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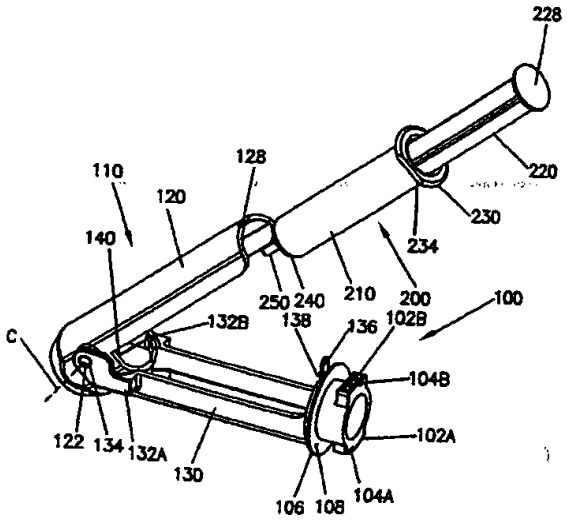


(57) Abstract: An adapter includes a syringe carrier adapted to seat at least a portion of the syringe. The syringe carrier includes at least one rearward facing abutment member to abut at least one forward facing surface of a syringe. The syringe carrier includes an opening therein to allow a drive member of an injector to communicate forward force to the plunger through abutment without connective engagement between the drive member and the plunger. The adapter further includes a releasable mounting mechanism positioned to the rear of the syringe carrier to mount the adapter in a desired position relative to the front wall of the injector. An adapter includes a first section and a second section that are rotatable relative to each other about a hinge axis generally perpendicular to a longitudinal axis of the adapter. An adapter includes a first section and a second section that are generally the same in construction, the first section and the section being connectable to form a syringe carrier to seat at least a portion of the syringe.

WO 01/08727 A1

INJECTOR SYSTEMS AND SYRINGE ADAPTERS FOR USE THEREWITH

Field of the Invention

The present invention relates to powered injector systems and syringe adapters for use therewith.

Background of the Invention

A number of injector-actuated syringes and powered injectors for use in medical procedures such as angiography, computed tomography, ultrasound and NMR/MRI have been developed. U.S. Patent No. 4,006,736, for example, discloses an injector and syringe for injecting fluid into the vascular system of a human being or an animal. Typically, such injectors comprise drive members such as pistons that connect to a syringe plunger. For example, U.S. Patent No. 4,677,980, the disclosure of which is incorporated herein by reference, discloses an angiographic injector and syringe wherein the drive member of the injector can be connected to, or disconnected from, the syringe plunger at any point along the travel path of the plunger via a releasable mechanism. A front-loading syringe and injector system is also disclosed in U.S. Patent No. 5,383,858, the disclosure of which is incorporated herein by reference.

As discussed in U.S. Patent No. 5,383,858, a syringe used with a front-loading injector preferably includes a readily releasable mounting mechanism for securing the syringe to the front wall of the injector. The use of specifically designed mounting mechanisms, however, prevents the use of syringes of other various types with front-loading injectors. Such syringes may, for example, include a syringe body, a plunger reciprocally mounted therein, and a plunger extension for transfer of force to the plunger.

positioned to the rear of the syringe carrier to mount the adapter in a desired position relative to the front wall of the injector.

The syringe may further include a transition region over which the radius or width of the syringe decreases (for example, a generally frusto-conical region) attached to a forward end of the body. The abutment member may abut a forward facing surface created by the transition region. Preferably, the abutment member abuts the transition region only in the vicinity of the transition from the body to the generally frusto-conical region (for example, at to the outer edge of the transition region).

The syringe may further include a syringe flange attached to a rearward end of the body of the syringe. The abutment member may abut a forward facing surface of the syringe flange. Preferably, the abutment member abuts the syringe flange only in the vicinity of the transition from the body to the syringe flange.

In one embodiment, the adapter includes a first section and a second section rotatable relative to each other about a hinge axis generally perpendicular to a longitudinal axis of the adapter. The first section and the second section are preferably rotatable about the hinge axis to an open position to allow loading of the syringe into the adapter from a position to the rear of the hinge axis. The first section and the second section are also preferably rotatable about the hinge axis to a closed position to form the syringe carrier.

In another embodiment, the adapter includes a first section and a second section that are generally the same in construction. The first section and the second section are connectable to form the syringe carrier and the releasable mounting mechanism.

The present invention also provides an adapter for releasably mounting a syringe in a desired position relative to a powered injector. The syringe preferably

example, include a first abutment surface positioned on a first lateral side of the syringe carrier section and a second abutment surface positioned on a second lateral side of the carrier section.

In another aspect, the present invention provides an adapter for releasably attaching a syringe to a front-loading powered injector including an intermediate section through which a push rod can pass to communicate force from the injector drive member to the plunger. The intermediate section has a releasable mounting mechanism positioned at a rear thereof to mount the adapter in a desired position relative to the front wall of the injector. The adapter also includes a syringe carrier section connected to the intermediate section. The syringe carrier section is adapted to seat at least a portion of the syringe and includes an opening in a rear section thereof to allow the drive member of the injector to communicate forward force to the plunger via the push rod.

The syringe carrier section is preferably open on a top thereof. A forward portion of the syringe carrier section abuts the transition region of the syringe during injection. The syringe carrier section is movable relative to the intermediate section to move the forward portion out of contact with the transition region of the syringe to enable removal of the syringe without retraction of the drive member. In one aspect, for example, the carrier section is connected to the intermediate section in a hinging manner.

In another aspect, an adapter system of the present invention includes an intermediate section having a releasable mounting mechanism positioned at a rear thereof as described above. The adapter system also includes a syringe carrier section connected to the intermediate section and adapted to seat at least a portion of the syringe. The syringe carrier section includes an opening in a rear section thereof to allow the drive member of the injector to communicate forward force to the plunger from the drive member and is preferably open on a top thereof. A forward portion of the syringe carrier section abuts the transition region of the syringe during an injection

releasable mounting mechanism as described above and a syringe carrier section adapted to seat at least a portion of the syringe. A forward abutment portion of the syringe carrier section abuts the transition region of the syringe. The syringe carrier section includes a biasing member to contact a rear surface of the syringe. The biasing member forces or biases the transition region of the syringe against the forward abutment portion for syringes of various lengths. The biasing member can, for example, be biased forward by a spring. The biasing member can also, for example, be biased forward by flexible member on a rear side thereof.

Brief Description of the Drawings

Other aspects of the invention and their advantages will be discerned from the following detailed description when read in connection with the accompanying drawings, in which:

Figure 1A illustrates an embodiment of an injector system of the present invention for use in connection with an MRI procedure.

Figure 1B illustrates the injector system of Figure 1A in which the saline syringe and the adapter have been disassembled from the injector.

Figure 2A illustrates a perspective view of an embodiment of an adapter of the present invention in an open state for loading of a syringe therein.

Figure 2B illustrates a perspective view of the adapter of Figure 2A in an open state with a syringe loaded therein.

Figure 2C illustrates a perspective view of the adapter of Figure 2A in a closed state with a syringe loaded therein.

Figure 2D illustrates a plan view of the adapter of Figure 2A in a closed state with a syringe loaded therein.

Figure 4F illustrates a perspective view of an adapter including another embodiment of a syringe retaining member.

Figure 4G illustrates a perspective view of an adapter including another embodiment of a syringe retaining member.

Figure 4H illustrates a perspective view of an adapter including another embodiment of a syringe retaining member.

Figure 4I illustrates a perspective view of an adapter including another embodiment of a syringe retaining member.

Figure 5A illustrates a perspective view of an embodiment of an adapter including separate, generally identical sections in an unconnected state.

Figure 5B illustrates a perspective view of the adapter of Figure 5A in a connected state.

Figure 6A illustrates a perspective view of another embodiment of an adapter including generally identical sections that are hingingly attached via a side wall thereof.

Figure 6B illustrates a front view of the adapter of Figure 6A in an open state.

Figure 6C illustrates a perspective view of the adapter of Figure 6A in a closed state.

Figure 7A illustrates a perspective view of another embodiment of an adapter including generally identical sections that are attached at a front end thereof in an open state.

intermediate section to allow removal of the syringe after an injection procedure without retraction of the injector drive member.

Figure 10B illustrates an expanded perspective view of the forward portion of the carrier section.

Figure 10C illustrates a perspective view of an embodiment of a syringe retainer for use in the adapter system.

Figure 10D illustrates a front cross-sectional view of the syringe retainer of Figure 10C.

Figure 11 illustrates a perspective view of an adapter system in which the push rod hinges to allow removal of the syringe after an injection procedure without retraction of the injector drive member.

Figure 12A illustrates a perspective view of an embodiment of an adapter assembly in a disconnected state including a contact or sealing member for removing injection fluids from a push rod.

Figure 12B illustrates a perspective view of the adapter assembly similar to the adapter assembly of Figure 12A in a connected state.

Figure 13A illustrates a perspective view of an embodiment of an adapter assembly including a biasing member to bias the syringe forward within the carrier section.

Figure 13B illustrates a perspective view of the adapter assembly of Figure 13A in a disconnected state.

Figure 14 illustrates a perspective view of another embodiment of a biasing member to bias the syringe forward within the carrier section.

injector 10 preferably includes a front wall 60 having a first opening 62 formed therein. Piston 40 is reciprocally mounted within injector 10 and is extendible through opening 62. Piston 40 preferably includes a piston flange or head 44. Receiving slots 66a and 66b, are preferably positioned opposite one another around opening 62. Receiving flanges 68a and 68b are preferably positioned opposite one another and between receiving slots 66a and 66b and extend inwardly into opening 62.

The rearward end of saline syringe 20 preferably includes a readily releasable mounting mechanism such as a pair of mounting flanges 22a and 22b for mounting saline syringe 20 in a desired position relative to the front wall 60 of injector 10. Flange 22b is not shown but is generally identical to flange 22a and positioned opposite flange 22a. Mounting flanges 22a and 22b may include indicating means, such as detent(s), bar code(s), protrusion(s) or notch(es) 24a, which provide information to the injector 10, for example, about the type of saline syringe 20 being used. Correspondingly, injector 10 preferably includes any suitable means (not shown) for reading information from notch(es) 24a.

To attach syringe 20 to injector 10, the rearward end of syringe 20 is inserted into injector opening 62 such that mounting flanges 22a and 22b are inserted into receiving slots 66a and 66b, respectively. If, at this time, plunger 40 is not positioned at the rearward end of syringe 20 such that a piston flange 44 can engage capture members 54 (as described in U.S. Patent No. 5,383,858), piston 40 may be advanced forward by the operation of injector 10 until piston flange 44 is in position to be received by capture members 54.

Once mounting flanges 22a and 22b are inserted into receiving slots 66a and 66b, respectively, and piston 40 is in position to be received by capture members 54, the operator preferably rotates syringe 20 approximately 90 degrees such that mounting flanges 22a and 22b move behind and are engaged by receiving flanges 68a and 68b, respectively, and piston flange 44 rotates into position to be retained by, for example, L-shaped capture members 54. Injector 10 may include a stop mechanism (not shown), for example, extending from at least one of the retaining

formed on a rearward portion of adapter 100 to, among other things, assist in forming a secure connection. Drip flange 106 may, for example, include a raised member or detent 108 (see, for example, Figure 2A)that mates with a recess (not shown) in the face of opening 62' to provide audible and/or tactile feedback to the operator upon proper alignment/connection of adapter 100 to injector 10.

After securely attaching adapter 100 to injector 10, advancing piston 40' in a forward direction will apply a motive force to a plunger extension 220 of syringe 200 to a advance syringe plunger 225 (see Figure 2E) forward within syringe barrel 210, thereby forcing contrast medium in syringe 200 out of syringe neck 250 into the fluid path to the patient.

Adapter 100 is illustrated in further detail in Figures 2A through 2E. In the embodiment of adapter 100, a "break" action is used to load syringe 200 into a carrier 110 of adapter 100. In that regard, carrier 110 includes a first portion or section 120 and a second portion or section 130. First portion 120 is hingingly attached to second portion 130 via support arms 132a and 132b, each of which includes a passage 134 therein. First portion 120 includes generally cylindrical tabs 122 on each side thereof that snap into passages 134 to hingingly or rotatably attach first portion 120 to second portion 130 about an axis C (see, for example, Figure 2D) preferably oriented generally perpendicular to longitudinal axis A of adapter 100.

Figure 2A illustrates adapter 100 in an open state and ready to receive syringe 200 from a position to the rear of the hinging mechanism. In this embodiment, syringe 200 comprises generally cylindrical body or barrel 210 in which a fluid such as contrast medium, saline or therapeutic agent is contained. Preferably, the fluid medium is "prefilled" into syringe 200 before loading of syringe 200 in adapter 100. Syringe 200 can, for example, be prefilled by the manufacturer or manually filled remote from the injector. Syringe 200 further includes plunger 225 slideably disposed within barrel 210 that is similar in operation to plunger 50 of saline syringe 20. Plunger 225 of syringe 200 is operatively connected to plunger extension rod 220 by, for example, a threaded connection. Syringe 200 further includes a flange 230 at a rearward

portion 154 can be made of a resilient or compliant material such as an elastomeric material that can be different from the material of the remainder of adapter 100 to further reduce the likelihood of failure.

In the case of a prefilled syringe 200, there is no need for the operator to retract the plunger of syringe 200 to load syringe 200 with contrast medium. Therefore, there is usually no need for a follower mechanism in the adapter of the present invention to attach to plunger extension rod 220 to enable retraction of plunger 225 as described in connection with the adapter of U.S. Patent No. 5,520,653. Piston 40' can simply be advanced to abut rearward surface 228 of plunger extension rod 220. Any further forward motion of piston 40' will result in advancement of the plunger of syringe 200 and pressurization of the contrast medium with syringe 200. Elimination of a carrier mechanism for the plunger extension simplifies and reduces the cost of manufacture of the adapters of the present invention as compared, for example, to the adapter of U.S. Patent No. 5,520,653. Nevertheless, the adapters of the present invention may readily be configured with follower mechanisms that connect to plunger extension rods 220 to allow plunger retraction.

Figures 2C through 2E illustrate syringe 200 within adapter 100 with first portion 120 and second portion 130 in a closed position. Adapter 100 preferably includes a mechanism to assist in maintaining first portion 120 and second portion 130 in a closed position during operation of injector 100. Second portion 130 may, for example, include a latch tab 136 having an abutment shoulder 138 that cooperates with a recess 128 in a rearward end of first portion 120 to create a snap latching mechanism. Many other closing mechanisms can be used to maintain first portion 120 and second portion 130 in a closed position, as clear to one skilled in the art.

Closed carrier 110 created by first portion 120 and second portion 130 also functions to limit the motion of plunger extension rod 220 out of alignment with axis A. This prevents plunger extension rod 220 from, for example, slipping out of contact with piston 40', prevents deforming of plunger extension rod 220 and prevents eccentric loading of plunger extension rod 220. Deflection, eccentric loading or

cylindrical tabs 122 is preferably, for example, positioned above the center line or longitudinal axis of carrier 110 such that a forward force exerted on shoulder 150 tends to produce a torque that maintains first portion 120 in a latched, closed position relative to second portion 130.

Once an injection procedure is completed, the operator can grasp the adapter or adapter/syringe combination and rotate it 90 degrees back to the pre-installation orientation, thereby, disengaging mounting flanges 102a and 102b from behind receiving flanges 68a and 68b, respectively. The adapter/syringe combination is then removable from the injector 10.

Retaining syringe 200 within carrier 110 by abutment with shoulder 150, allows accommodation of many different designs of syringe 200 by carrier 110. Adapter 100 is thus usable with a wide variety of currently available syringes 200.

Figures 3A through 3E illustrate another embodiment of an adapter 300 for use with a syringe 200. The rearward portion of adapter 300 is essentially identical to that of adapter 100 and is removably attached to injector 10 as described above. Unlike adapter 100, which holds syringe 200 within adapter 100 and provides resistance to the forward force applied to plunger extension rod 220 by abutment of syringe flange 230, syringe 200 is held within adapter 300 and resistance provided to the forward force applied to plunger extension rod 220 by abutting a forward facing surface of forward transition region 240 of syringe 200 rather than by abutting or retaining syringe flange 230.

Like adapter 200, a hinging or "break" action is used to load syringe 200 into a carrier 310 of adapter 300. In that regard, carrier 310 includes a first portion 320 and a second portion 330. First portion 320 is hingingly or rotatably attached to second portion 330 via support arms 332a and 332b, each of which includes a passage 334 therein. First portion 320 includes generally cylindrical tabs 322 on each side thereof that reside in passages 334 to hingingly attach first portion 320 to second portion 330.

profile to conform to flattened section(s) 234 of syringe flange 230 to prevent rotation of syringe 200. The cooperation of such a flattened profile of carrier 310 and section 234 can, for example, be used to ensure a desired orientation of syringe barrel 210 with open areas 344. For example, two open areas 344 can be provided generally opposing each other (that is, positioned approximately 180° apart on forward portion 342). The cooperation of a flattened profile of carrier 310 and flattened syringe flange section 234 in this embodiment preferably allows mounting of syringe 200 in carrier 310 in only two axially rotated orientations, 180° apart.

One or a plurality of inward projecting guide 360 can be formed in one or both of first portion 120 and second portion 130 to maintain tight tolerances to prevent deflection of plunger extension rod 330 as discussed above. A plurality (for example, three) guides 360 can be used about first portion 120 and/or second portion 130 to limit or prevent deflection in any direction.

Open areas (not shown) can also be provided on carrier 310 in the area where syringe flange 230 resides to accommodate large (in a radial direction) or irregularly shaped syringe flanges 230. Such open areas preferably extend longitudinally to accommodate syringes of different length from a forward end thereof to the syringe flange thereof. In general, the adapters of the present invention preferably provide adequate capacity to accommodate syringes of widely varying length, diameter etc.

An important function of an injector is to monitor and report the actual volume of fluid available for delivery within a syringe. This function, for example, enables rapid decision on whether enough fluid is present to proceed with an imaging procedure or whether additional volume should be loaded. Monitoring the cumulative volume of fluid delivered to a patient is also desirable for certain applications where a recommended per-patient dosage volume should not be exceeded. Fluid volumes delivered by injectors are typically displayed in 1.0 ml increments and are tracked by the injector with finer resolution than is displayed. Injectors also preferably detect

embodiment of adapter 300. Multiple adapter combinations decrease the ease of use for an operator and expand the logic and sensing capacity required of injector 10. An optimum approach would be to use a single adapter that accommodates all hand syringes targeted for a particular injector. To approach this goal, it is preferable to retain/abut a front end of syringes 200 as described above in connection with adapter 300 so that injector 10 can determine the position of the front end of syringe 200. Loading of a front end of syringe 200 is also preferred to take advantage of an area of increased syringe strength to prevent syringe failure.

Figures 4A through 4C illustrate another embodiment of an adapter 400 for use with syringe 200. The rearward portion of adapter 400 is essentially identical to that of adapters 100 and 300 and is removably attached to injector 10 as described above. Unlike adapters 100 and 300, which incorporate a hinging action to enclose syringe 200, syringe 400 includes an open carrier 410. Like adapter 300, however, syringe 200 is held within adapter 400 and resistance provided to the forward force applied to plunger extension rod 220 by abutting forward transition or cone region 240 of syringe 200.

As illustrated in Figures 4A and 4B, syringe 200 is simply loaded into adapter 400 by dropping syringe 200 therein from above. Adapter 400 preferably includes a first, rearward portion 420 that seats/supports syringe flange 230. Preferably, first portion 420 has generally flat side walls 422 that cooperate with generally flat sections 234 on syringe flange 230 to restrict or substantially prevent rotation of syringe 200 within adapter 400. Side walls 422 of first portion 420 preferably extend upward past the generally common axis of syringe 200 and adapter 400 to assist in supporting syringe 200.

Adapter 400 further includes a second, forward portion 430 that seats/supports syringe barrel 210. Second portion 430 preferably includes a radially inward extending abutment shoulder 450 that abuts cone or transition region 340 of syringe 200 to retain syringe 200 within adapter 400 and provide resistance to the forward force applied to plunger extension rod 220 by piston 40'. Although second

position on second portion 430 when syringe is loaded into carrier 410 to facilitate loading. Retaining member 460a is retained on second portion 430 by abutment with a forward shoulder 480 and rearward shoulder 482. After seating of syringe 200, retaining member 450a can preferably be slid to any desired position on second portion. Positioning retaining member 460A at a rearwardmost position on second portion 430 may maximize stability. Retaining member 460a preferably conforms closely to the shape of syringe barrel 210 to maximize stability. Retaining member 460a may include an open section 462a on the top thereof to facilitate removal of syringe 200 from carrier 410 without disconnection of an attached fluid path element.

Figure 4F illustrates another embodiment of a slideable retaining member 460b. Retaining member 460b is slideably retained upon first portion 420 of carrier 410 between drip flange 106 and shoulder 484. To facilitate loading of syringe 200, retaining member 450b may be positioned near drip flange 106. After loading of syringe 200, retaining member 460b can be slid to a desired position. An opening (not shown) in retaining member 460b can be formed to facilitate removal of syringe 200 from carrier 410 without disconnection of an attached fluid path element.

In the embodiment of Figure 4G, a retaining mechanism includes two cantilevered retaining member 460c' and 460c" that snap around syringe barrel 210 upon loading of syringe 200 in carrier 410.

A plurality of retaining/stabilizing members as described above can be provided along the length of carrier 410 to assist in retaining/stabilizing syringe barrel 210 and plunger extension rod 420 in proper position within carrier 410. The opening and closing of such retaining members can be operated individually or collectively, for example, via a common tab.

Alternatively, a retaining/stabilizing member can be increased in axially length to increase stability. For example, Figure 4H illustrates a retaining member 460d hingingly attached to first portion 420 that extends along the entire

adapter 500 encompasses both syringe barrel 210 and plunger extension rod 220 to retain/stabilize syringe 200. The side walls of adapter 500 can be formed with a generally flat or flattened profile to interact with/abut generally flat section(s) 234 of syringe flange 230 to prevent rotation of syringe 200 about its axis within adapter 200.

To facilitate viewing of either plunger extension rod 220 or barrel 210, adapter 500 can be formed with cut out window sections 540. Moreover, any portion or all of adapter 500 can be transparent.

Adapter 500 provides resistance to the forward force applied to plunger extension rod 220 by abutment of syringe transition region 240 with a radially inward extending shoulder section 550. The advantages of providing such resistance/retention by abutment of syringe transition region 240 discussed above in connection with other embodiments of adapter of the present invention are also provided by adapter 500.

Another embodiment of an adapter 500' is illustrated in Figures 6A through 6C. Adapter 500' is generally identical to adapter 500 except that adapter 500' is formed from the connection of a first portion 510a' and a second portion 510b' that are initially hinged together, for example by a notched plastic hinge 512 as known in the art) as best illustrated in Figures 6A and 6B.

Figures 7A through 7C illustrate another embodiment of an adapter 600 of the present invention. Adapter 600 includes a first member 610a and a second member 610b that are attached via a forward hinge mechanism. The hinge mechanism preferably includes a generally cylindrical member 612 on an extending member 614 of one of first member 610a and second 610b that is rotatably seatable in a passage 616 formed in an extending member of the other of first member 610a and second member 610b. Extending members 614 preferably extend forward on each side of a forward end of each of first member 610a and second member 610b as illustrated in Figure 7A.

saline syringe 720 attached to a second face plate 705'. In the embodiment of Figure 8A, face plate 705 is rotated upward to be detached from the injector.

Figure 8B illustrates an embodiment of an adapter 800 including a carrier 810 formed integrally or attached to a face plate 805 suitable for attachment to the injector of Figure 8A. Syringe 200 can be "breach" loaded into carrier 810 by first tilting syringe 200 and advancing barrel 210 of syringe 200 in a forward direction through passage 840 formed in a forward most position of an enclosed forward section 830 of carrier 810. Syringe 200 is advanced until syringe cone region 240 abuts radially inwardly extending shoulder 850 that defines passage 840. Face plate 805 includes a passage 808 therein through which a piston (not shown) of the injector of Figure 8A can pass to cooperate with plunger extension rod 220.

Figure 8C illustrates an embodiment of an adapter 900 that includes a carrier 910 attached to a removable face plate 905. In this embodiment, syringe 200 is advanced through passage 908 in face plate 902. Syringe 200 is advanced forward until cone region 240 abuts radially inward extending shoulder 950 of carrier 910.

Figure 8D illustrates an embodiment of an adapter 1000 that includes a carrier 1010 attached to a removable face plate 1005. Syringe 200 is loaded into carrier 1010 from the top by dropping syringe 200 into carrier 1010. When seated in carrier 1010, syringe 200 abuts radially inward extending shoulder 1050 of carrier 1010. The top of carrier 1010 is maintained in an open state over the length of carrier 1010 to facilitate removal of syringe 200 even when connected to a fluid path element.

Figure 8E illustrates an embodiment of an adapter 1100 that includes a carrier 1110 attached to a removable face plate 1105. Like adapter 1010, syringe 200 is loaded into carrier 1110 from the top by dropping syringe 200 into carrier 1110. When seated in carrier 1110, syringe transition region 240 abuts radially inward extending shoulder 1150 of carrier 1110. Carrier 1110 includes a hinging cover section 1160 that can be rotated to a closed position to form a cover/retainer over at

retraction of plunger 225 within syringe 200 will not be required. Push rod forward end 1244 is preferably of generally the shape of the rearward facing interior of plunger 225. In this manner, push rod forward end 1244 provides support to plunger 225 to maintain the shape of plunger 225 during use of syringe 200. In many cases, plunger 225 will be fabricated predominantly from an elastomeric cover material. If the side walls of plunger 225 do not make adequate sealing contact with the interior side wall of syringe barrel 210, leakage of contrast to the rear of plunger 225 can occur during advancement of plunger 225.

Figures 10A through 10D illustrate another embodiment of an adapter system 1300 of the present invention. Similar to adapter system 1200, adapter system 1300 includes a carrier section 1310, an intermediate section 1320, and a rearwardmost connecting section 1330. Adapter system 1300 further includes or operates with a push rod 1340. Syringe 200 is seated in open carrier section 1310 by placing syringe 200 into carrier section 1310 from above (and can be seated therein or removed thereform without removal or any attached tubing). Forward transition or cone region 240 abuts a shoulder portion 1350 of carrier section 1310.

To minimize fabrication costs of adapter system 1300, it is desirable that the option of using, for example, less expensive, lower-strength polymeric materials be available. Because the top portion of carrier section 1310 and shoulder 1350 are open for ease of removal of syringe 200, asymmetrical loading of connecting section 1330 can occur if cone region 240 of syringe 200 contacts a bottom portion of shoulder portion 1350 (as in the case of shoulder 1240, for example) during advancement of push rod 1340. The resulting bending moment about connection section 1330 can cause failure of adapter system 1300. To substantially reduce or eliminate asymmetrical loading, shoulder portion 1350 is preferably shaped to prevent such asymmetrical loading by, for example, being open on the top and bottom thereof (see, Figure 10B). Removing a bottom edge of abutment shoulder 1350 where cone region 240 of syringe 200 would otherwise rest results in generally symmetrical loading about the axis of adapter system 1300 (and syringe 200) and substantially reduces or removes lateral loads and bending moments

In the embodiment of Figure 10A, retainer section 1310 is movably connected (for example, hingedly or even removably connected) to intermediate section 1320. By, for example, rotating carrier section 1310 downward so that syringe 200 can be pulled forward without contacting the forward portion of carrier 1310, syringe 200 can be released and removed without retracting the plunger thereof following a full or partial injection.

In the embodiment of Figure 10A, carrier section 1310 is hingedly attached to intermediate section 1320 via pin joints (not shown) on each side thereof. Carrier section 1310 rotates about such pin points when closing the adapter assembly until extending members 1370 and 1372 contact abutment surfaces 1374 on intermediate section 1320. At that point, intermediate section 1320 is generally aligned with carrier section 1310, and carrier section 1310 is in position for shoulder 1350 to abut syringe transition region 240. A locking ring 1380 is preferably slidably positioned on extending members 1370 and 1372. After carrier section 1310 is rotated to a closed position, locking ring 1380 is slid rearward to abut a flange 1390 formed on the lower half of the front of intermediate section 1310 to lock carrier section 1310 in a closed position.

Figure 11 illustrates another embodiment of an adapter system 1400 that is very similar to adapter system 1300. However, carrier section 1410 is not hingedly attached to intermediate section 1420. In this embodiment, push rod 1440 includes a movable section (for example, hinging or rotating section 1442) positioned forward of intermediate section 1420. Hinging section 1442 allows syringe 200 to be moved (rotated, in this embodiment) out of alignment with the axis of adapter system 1400 so that syringe 200 can be removed without retracting the drive member of the injector following a full or partial injection.

Figures 12A and 12B illustrate an adapter system 1500 that includes a carrier section 1510, an intermediate section 1520 and a connector section 1530 as discussed above. Adapter system 1500 includes a cleaning or contact member such as a wiper seal 1570 and retainer ring 1580 for positioning wiper seal 1570 within

Figure 14 illustrates another forward biasing abutment member 1770 suitable for use in an adapter system 1700 to bias syringe 200 completely forward within carrier section 1710. Abutment member 1770 is slidably seated within carrier section 1710 and includes flex members 1772 that abut, for example, a forward facing surface 1712 of carrier section 1710 and bias abutment member 1770 forward. Abutment member 1770 of Figure 14 includes three sets of inward projecting protrusions 1774 for contacting rear flange 230 of syringe 200. Multiple sets of protrusions 1774 are provided to accommodate multiple syringe lengths. Flex members 1772 push against surface 1712 when syringe 200 is in place, thereby biasing syringe 200 in a fully forward position within carrier section 1710 regardless of syringe length.

Although the present invention has been described in detail in connection with the above examples, it is to be understood that such detail is solely for that purpose and that variations can be made by those skilled in the art without departing from the spirit of the invention except as it may be limited by the following claims.

8. An adapter for releasably attaching a syringe to a powered injector including a drive member reciprocally mounted therein, the adapter comprising:

a first section and a second section, the first section and the second section being rotatable relative to each other about a hinge axis generally perpendicular to a longitudinal axis of the adapter, the first section and the second section being rotatable about the hinge axis to an open position to allow loading of the syringe into the adapter from a position to the rear of the hinge axis, the first section and the second section also being rotatable about the hinge axis to a closed position to form a syringe carrier to seat at least a portion of the syringe.

9. The adapter of Claim 8 wherein the powered injector further includes a front wall, and the adapter further includes a releasable mounting mechanism positioned to the rear of the syringe carrier to mount the adapter in a desired position relative to the front wall of the injector.

10. An adapter for releasably attaching a syringe to a powered injector including a drive member reciprocally mounted therein, the adapter comprising:

a first section and a second section, the first section and the second section being generally the same in construction, the first section and the second section being connectable to form a syringe carrier to seat at least a portion of the syringe.

11. The adapter of Claim 10 wherein the injector further includes a front wall, and the first section and the second section also form a releasable mounting mechanism positioned to the rear of the syringe carrier to mount the adapter in a desired position relative to the front wall of the injector.

12. The adapter of Claim 6, further comprising a releasable latch to maintain the first section and the second section in the closed position.

22. The adapter of Claim 21, further comprising at least one syringe retaining mechanism for retaining the syringe within the carrier during an injection.

23. The adapter of Claim 22 wherein the retaining mechanism is rotatable around an axis of the adapter between an open position and a closed position.

24. The adapter of Claim 22 wherein the retaining mechanism is slidable along an axis of the adapter.

25. The adapter of Claim 22 wherein the retaining mechanism comprises at least one extending member that is biased in a position to retain the syringe in the adapter.

26. The adapter of Claim 22 wherein the retaining mechanism is hingedly attached to one side of the adapter to be movable between an open position and a closed position.

27. The adapter of Claim 1 wherein the releasable mounting mechanism comprises a plate that is removably attachable to the front wall of the injector.

28. The adapter of Claim 9 wherein the releasable mounting mechanism comprises flanges that cooperate with the injector to mount the adapter on the injector.

29. The adapter of Claim 9, further comprising a sealing flange positioned forward of the mounting mechanism to abut the front wall of the injector.

30. The adapter of Claim 8, further comprising indicia to provide information to the injector.

39. The adapter of Claim 38 wherein the abutment member abuts the transition region in the vicinity of the transition from the body to the transition region.

40. The adapter of Claim 39 wherein the abutment member comprises a resilient material to abut the syringe flange in the vicinity of the transition from the body to the transition region.

41. The adapter of Claim 8 wherein at least a portion of the adapter is formed to enable viewing of the syringe.

42. The adapter of Claim 9 wherein the releasable mounting mechanism comprises a plate that is removably attachable to the front wall of the injector.

43. The adapter of Claim 11 wherein the releasable mounting mechanism comprises flanges that cooperate with the injector to mount the adapter on the injector.

44. The adapter of Claim 43, further comprising a sealing flange positioned forward of the mounting mechanism to abut the front wall of the injector.

45. The adapter of Claim 43 wherein the cooperation between the releasable mounting mechanism and the injector maintains the first section and the second section in a closed relationship.

46. The adapter of Claim 10, further comprising indicia to provide information to the injector.

47. The adapter of Claim 10, further comprising at least one syringe abutment member to prevent the syringe from rotating within the adapter.

56. The adapter of Claim 55 wherein the abutment member comprises a resilient material to abut the transition in the vicinity of the transition from the body to the transition region.

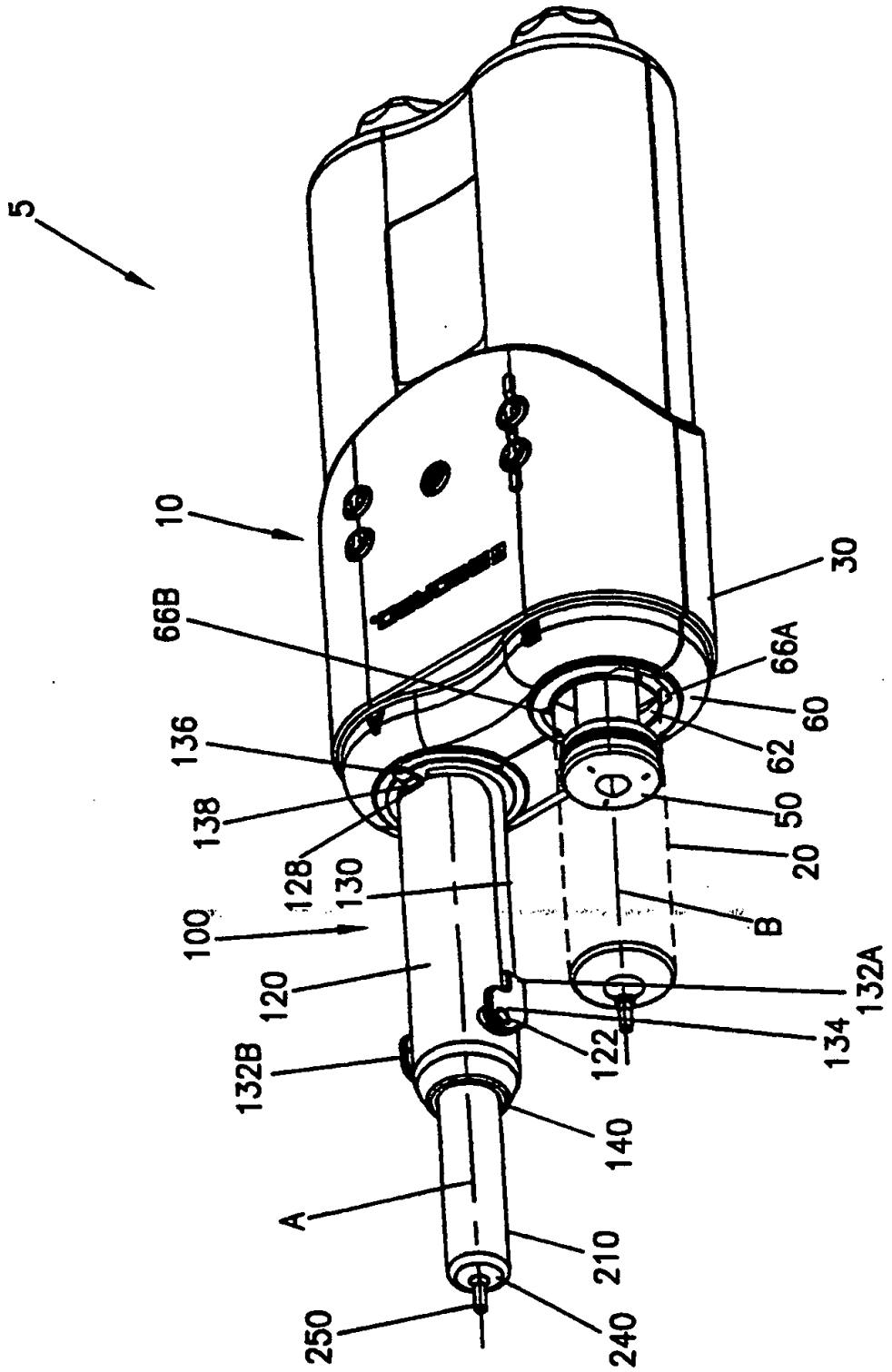
57. The adapter of Claim 11 wherein the releasable mounting mechanism comprises a plate that is removably attachable to the front wall of the injector.

58. An adapter for releasably attaching a syringe to a front-loading powered injector, wherein the syringe comprises a body, a syringe flange attached to a rearward end of the body, and wherein the injector comprises a front wall, an opening formed in the front wall, and a drive member reciprocally mounted in the injector, the adapter comprising:

a syringe carrier adapted to seat at least a portion of the syringe, the syringe carrier including at least one rearward facing abutment member operable to abut the syringe flange only in the vicinity of the transition from the body to the syringe flange, the syringe carrier comprising an opening therein to allow the drive member of the injector to communicate with an interior of the syringe to pressurize fluid within the syringe; and

a releasable mounting mechanism positioned to the rear of the syringe carrier to mount the adapter in a desired position relative to the front wall of the injector.

59. The adapter of Claim 58 wherein the abutment member comprises a resilient material to abut the syringe flange in the vicinity of the transition from the body to the syringe flange.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10
66B
136
138
128
130
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132B
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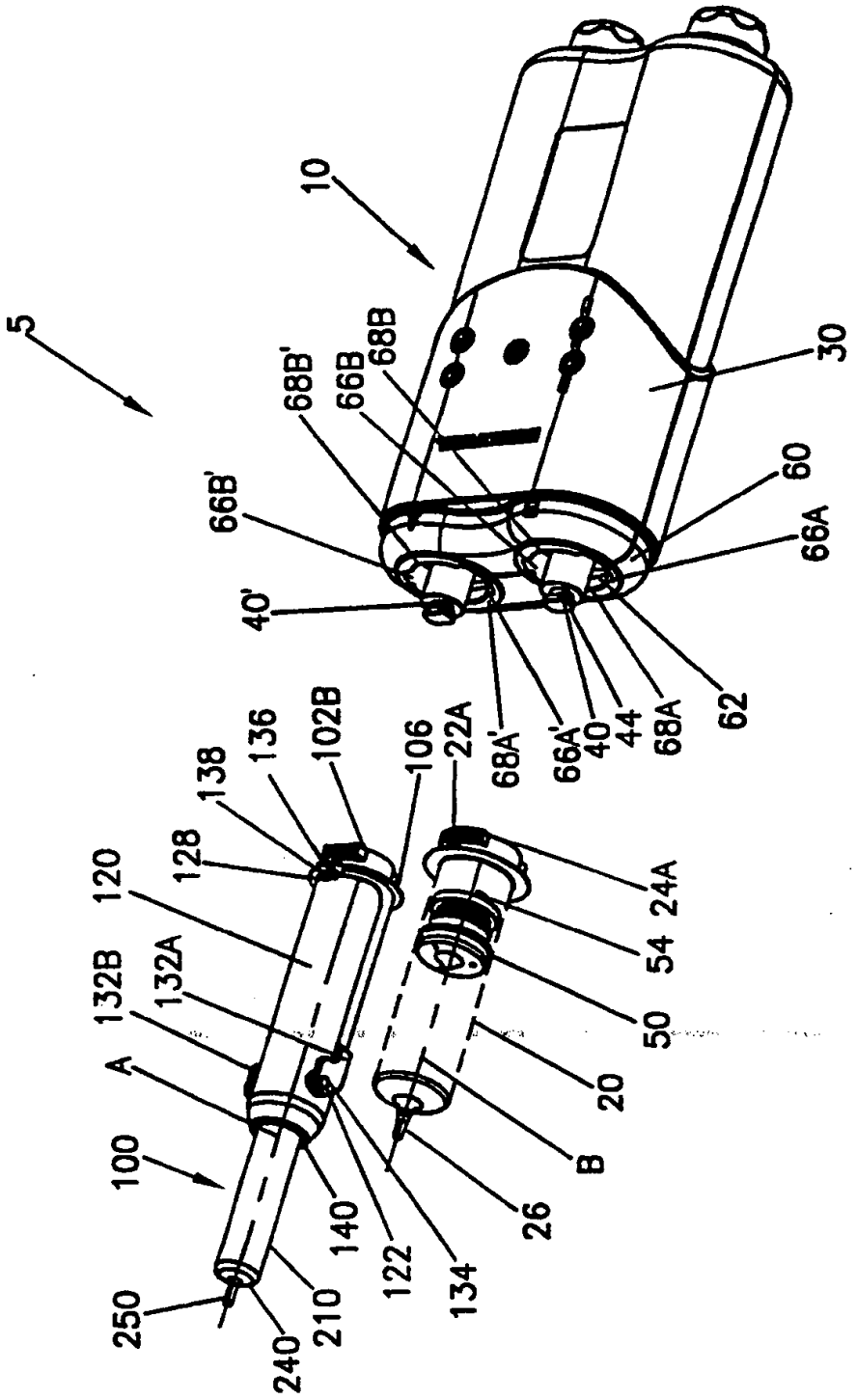
250
240
210
140
122
134
132A
B
20
50
62
60
66A
30

FIG. 1A


5
10
30
60
66A
66B'
68B'
68B
66B
40'
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68A
44
40
66A'
68A'
22A
106
102B
136
138
128
120
24A
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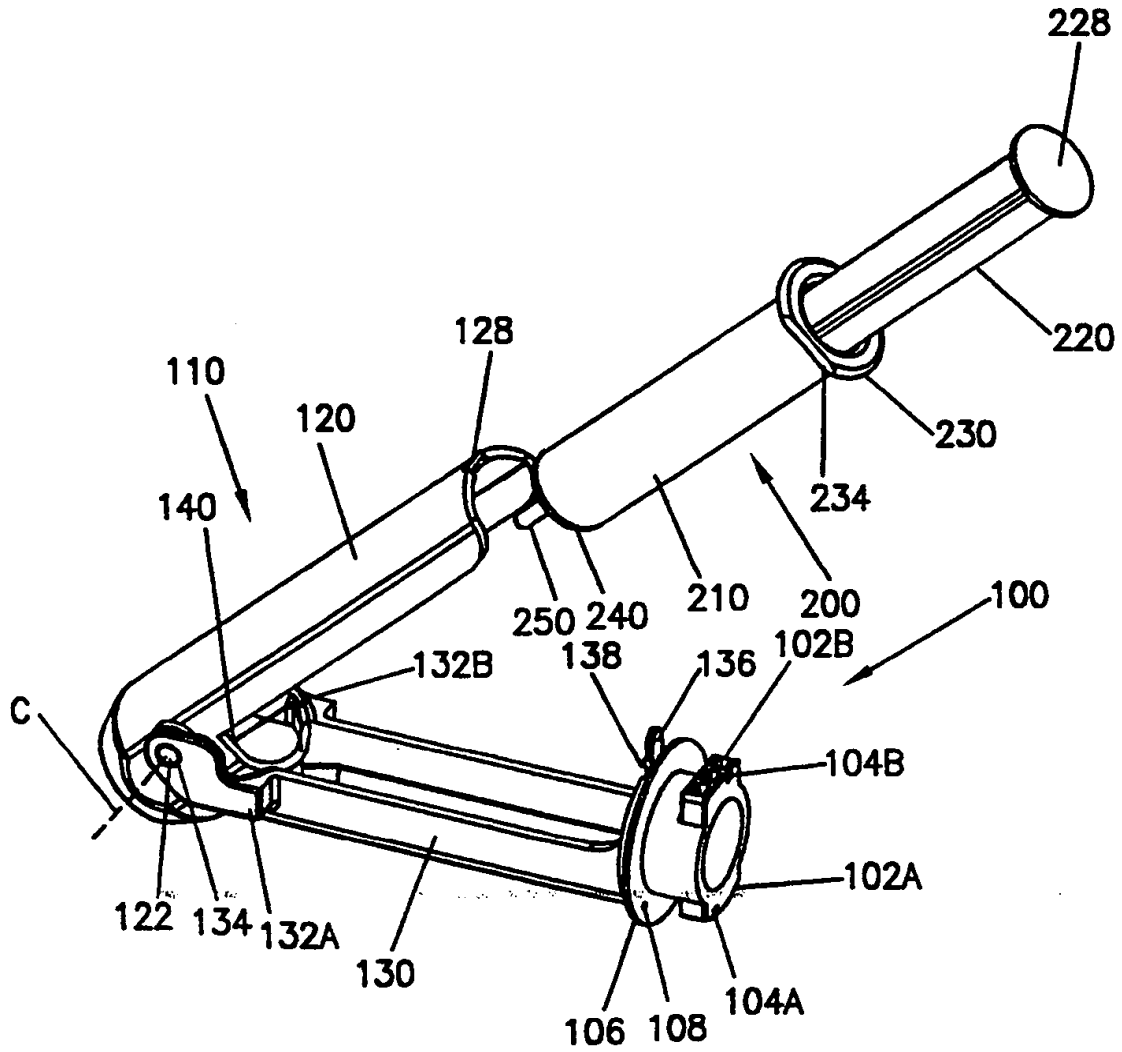
50
20
B
26
132B
132A
A
100
140
122
134
250
210
240

FIG. 1B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220
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128
110
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140
250
240
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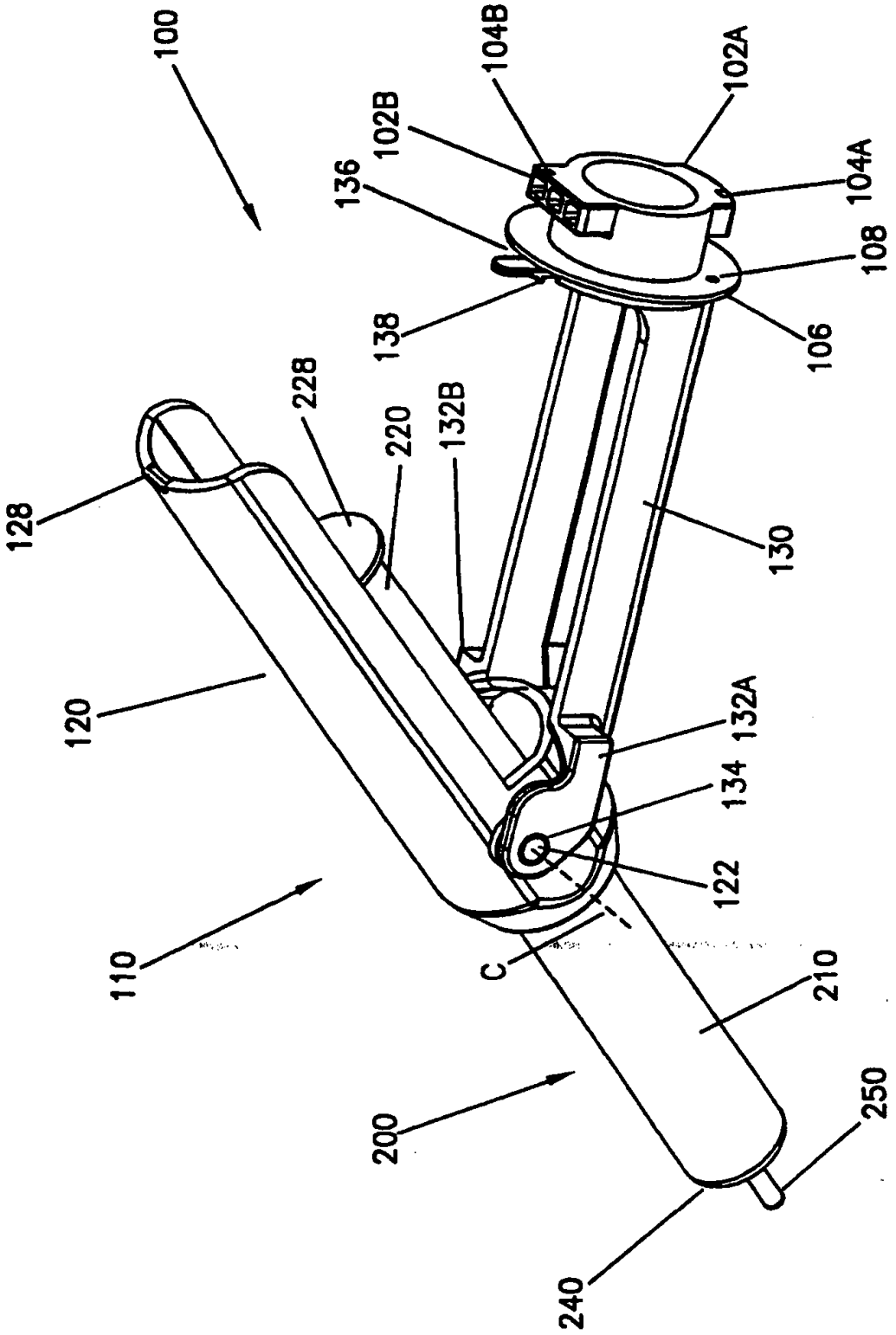
200
100
138
136
102B
132B
C
104B
102A
122
134
132A
130
106
108
104A

FIG. 2A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104B
102A
102B
136
104A
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132B
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130
120
132A
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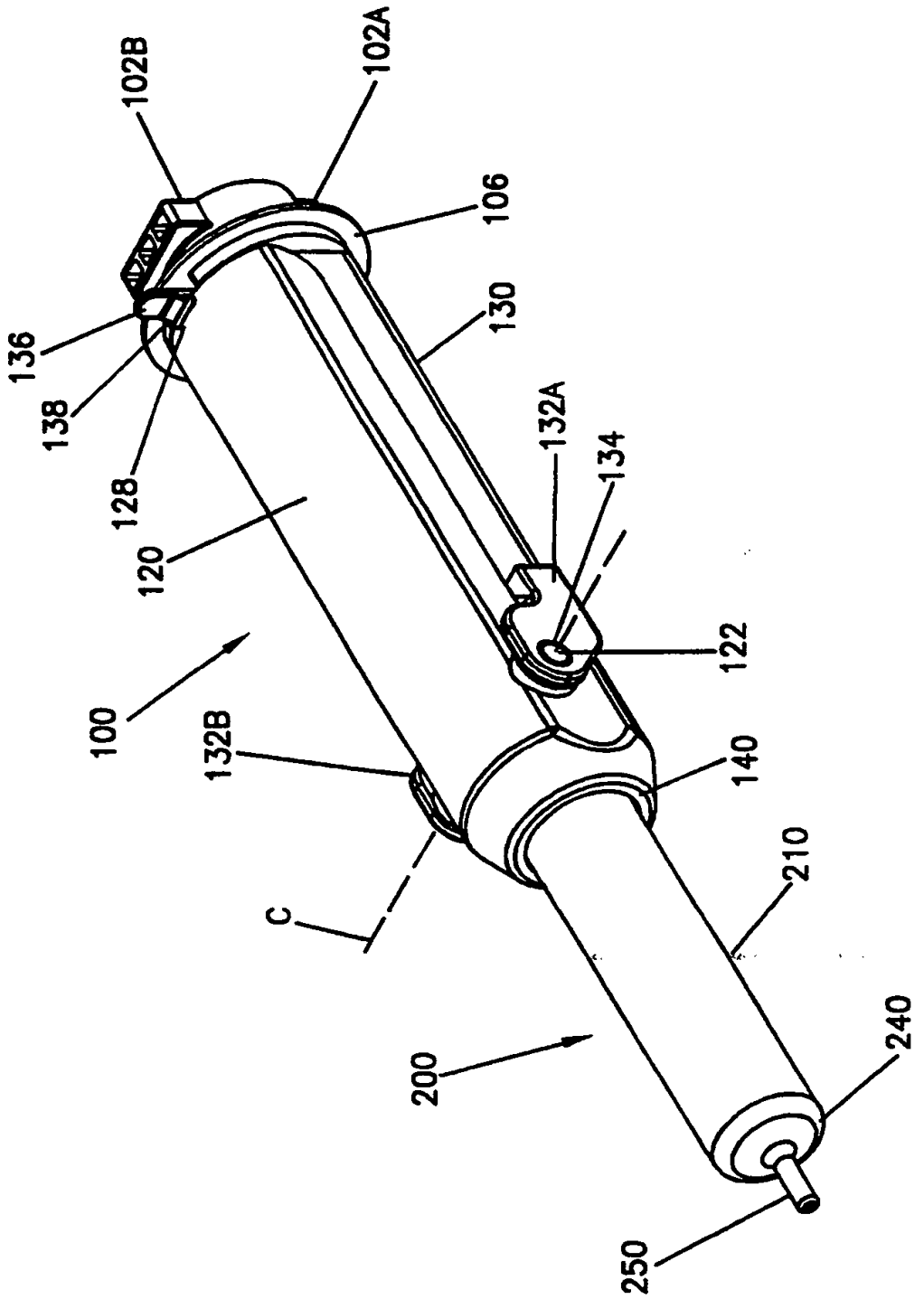
110
C
210
200
250
240

FIG. 2B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132B
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210
C
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240
250

FIG. 2C

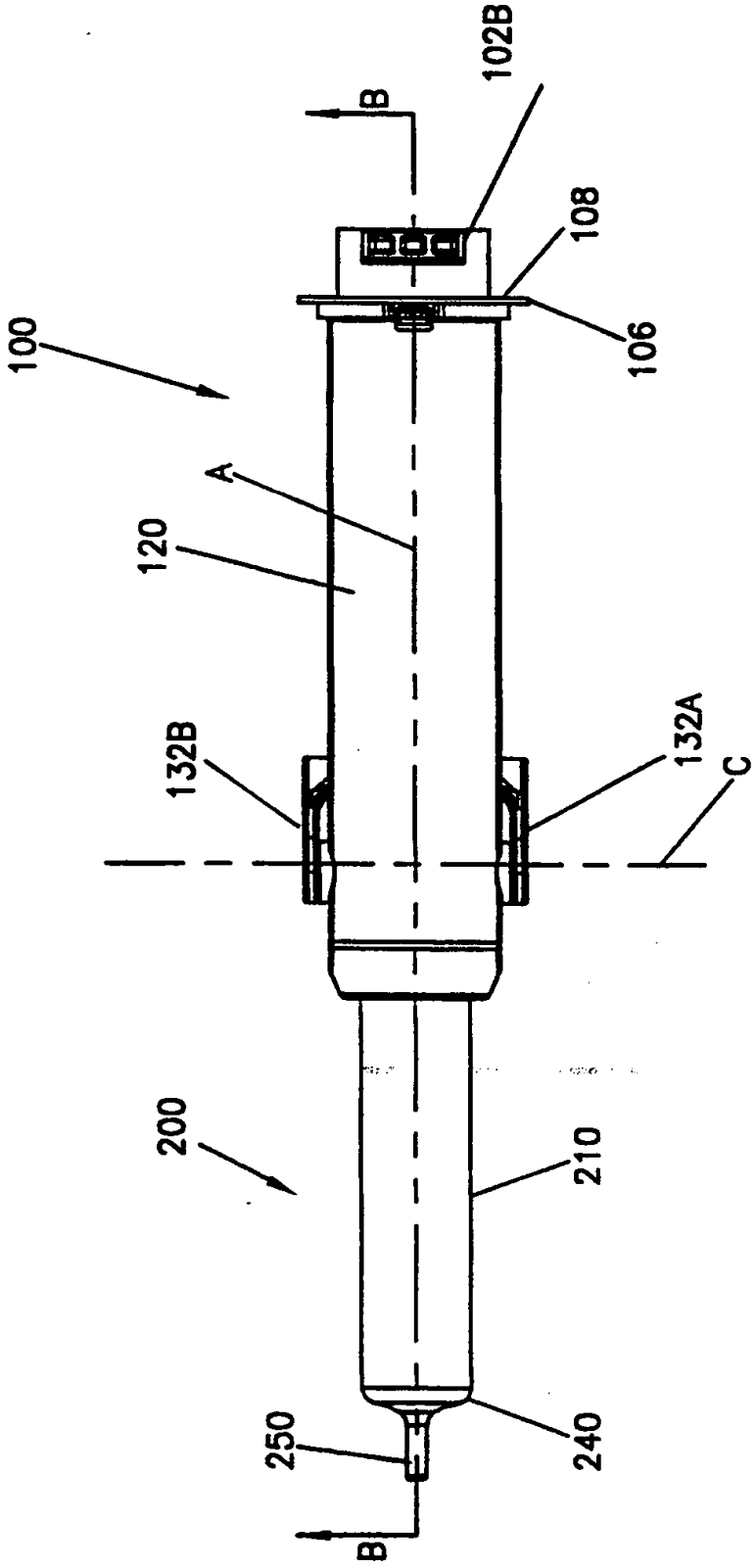
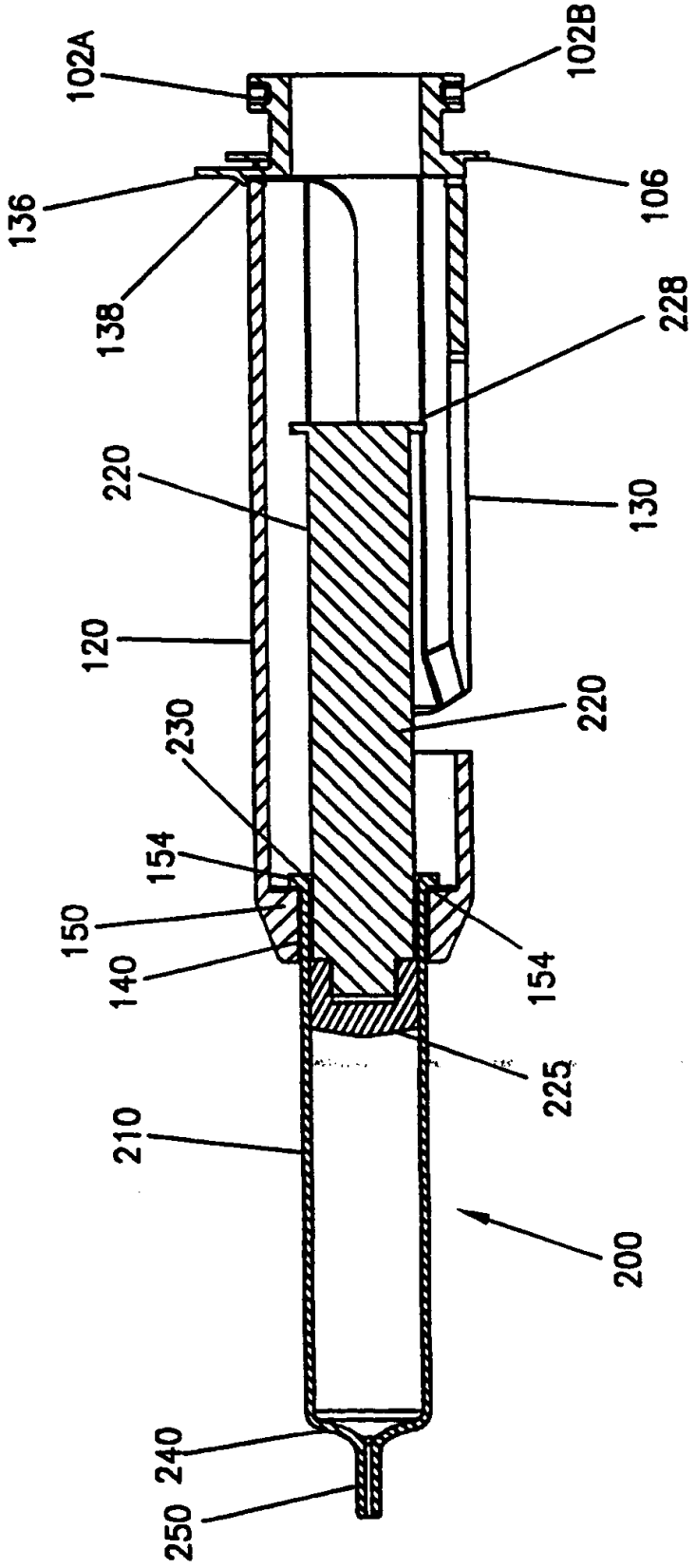


FIG. 2D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102B
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230
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154
225
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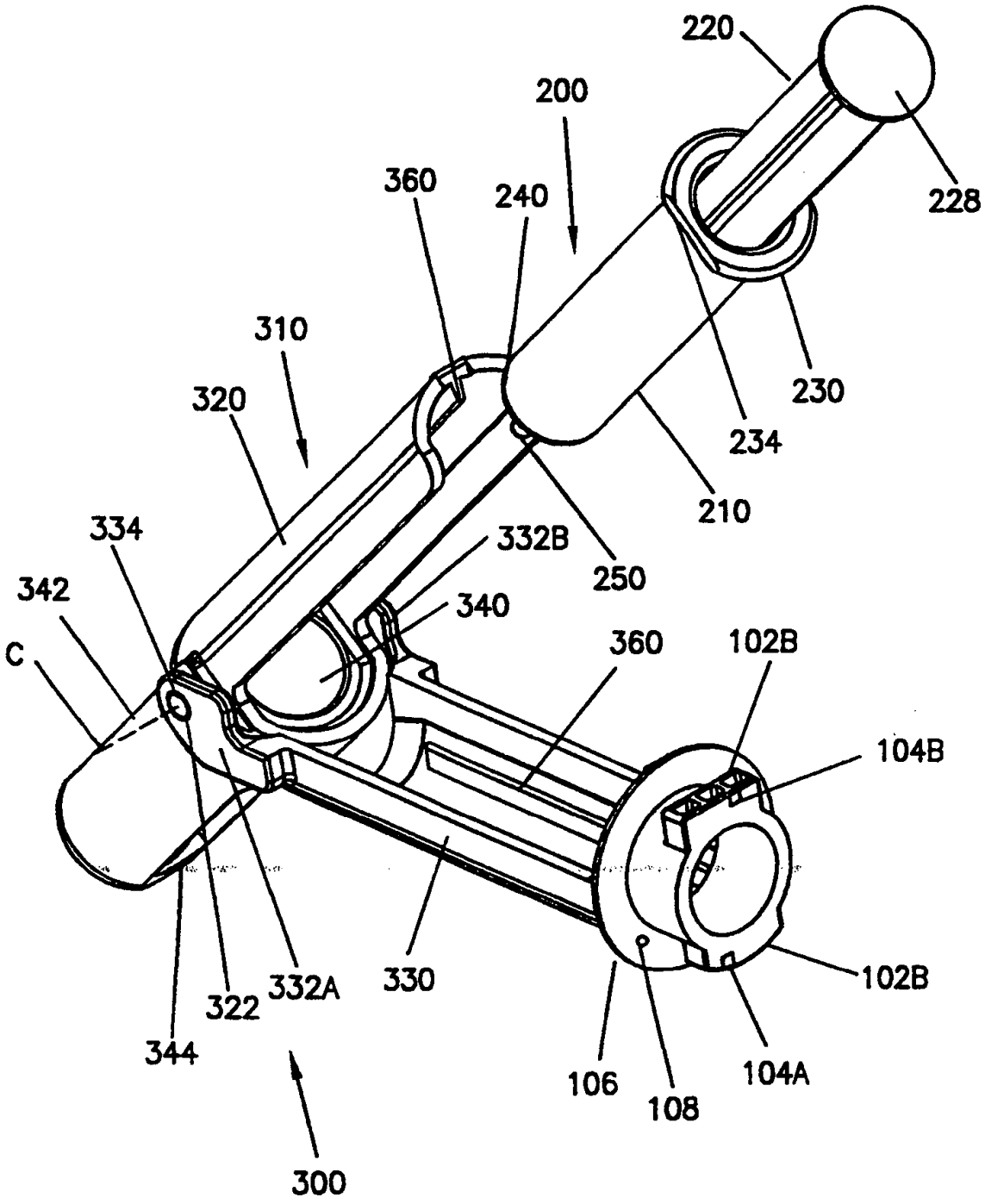
240
250

FIG. 2E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230
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210
334
332B
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342
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C
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330
332A
322
344
102B
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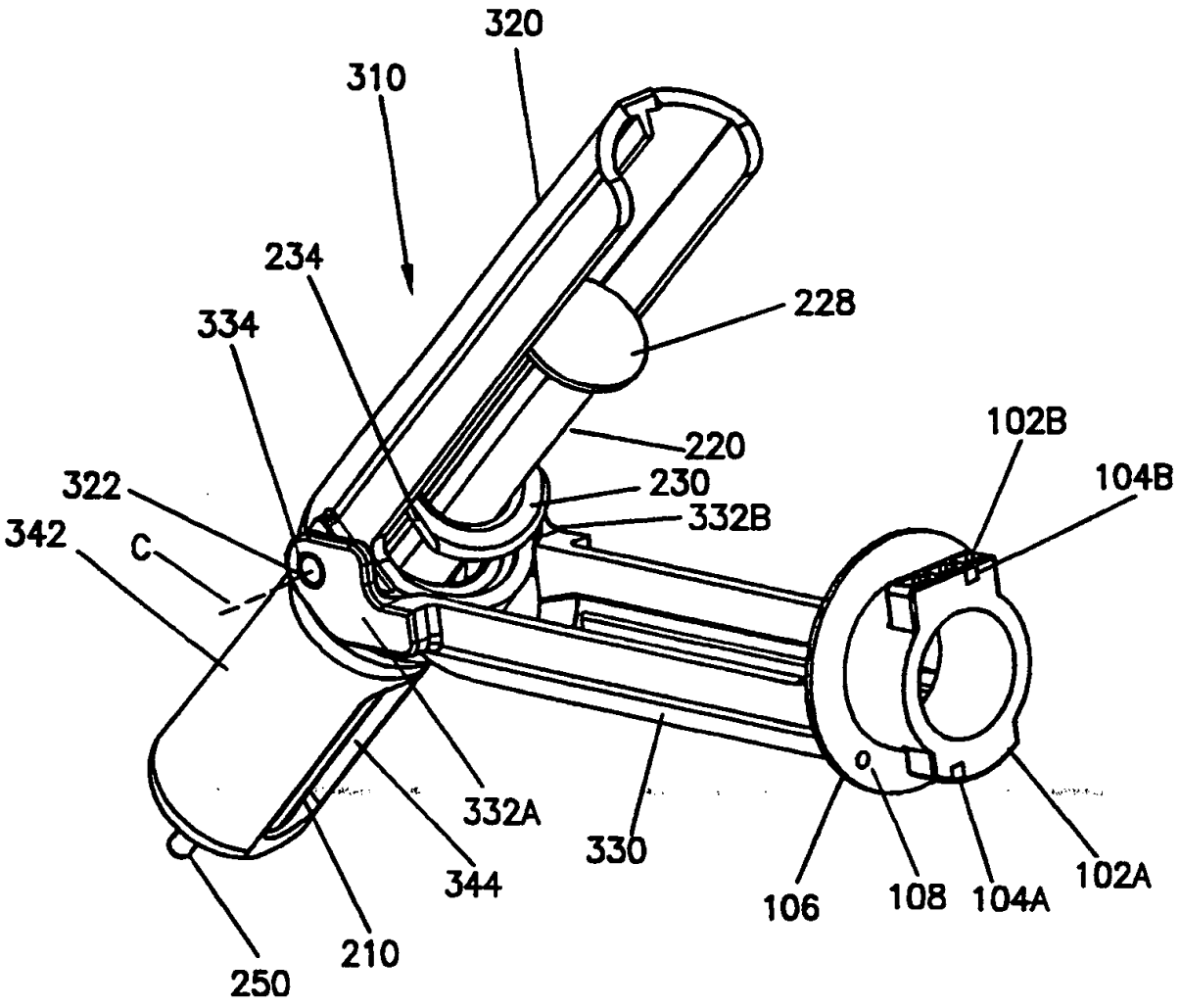
108
104A
300

FIG. 3A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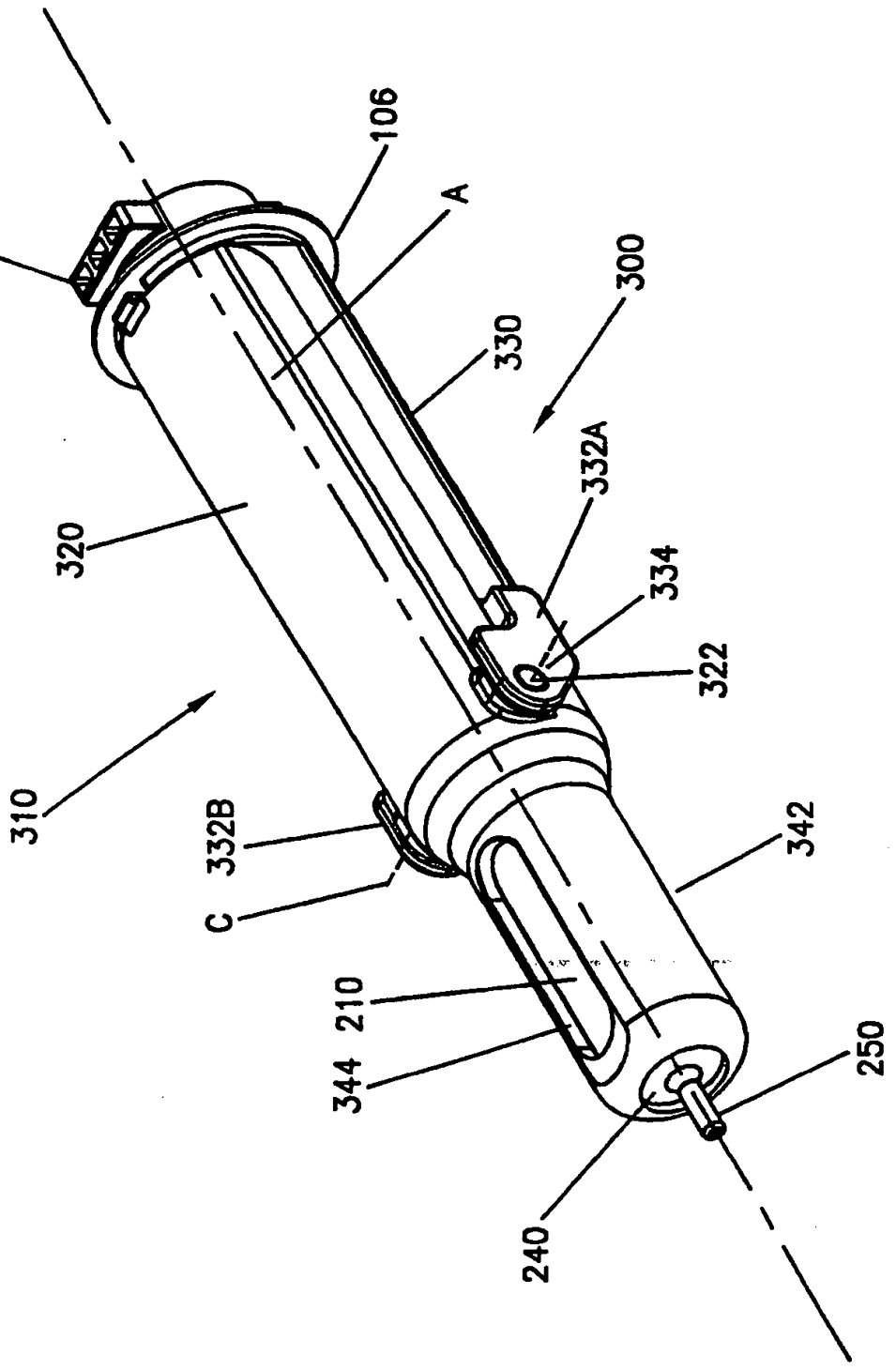
332B
342
C
332A
330
344
106
108
104A
102A
210
250

FIG. 3B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332A
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310
332B
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C
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344
250
240

FIG. 3C

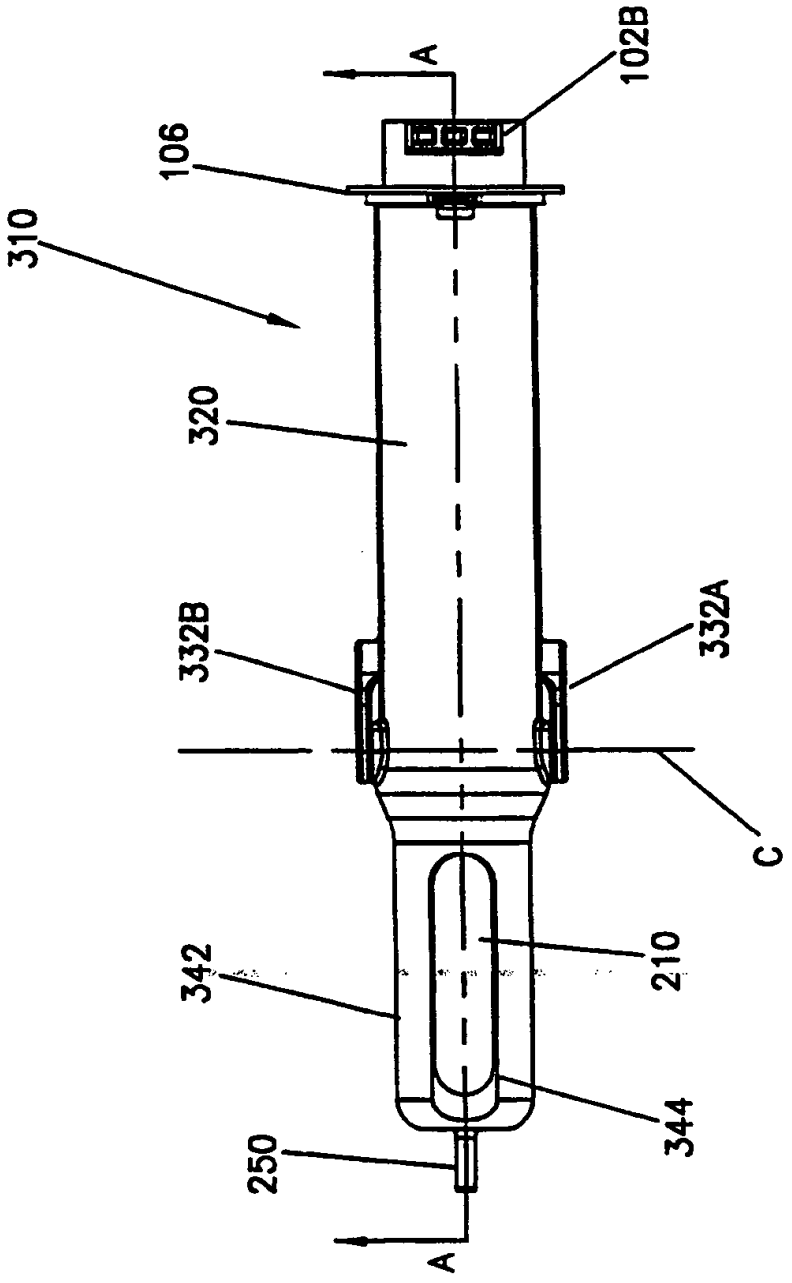
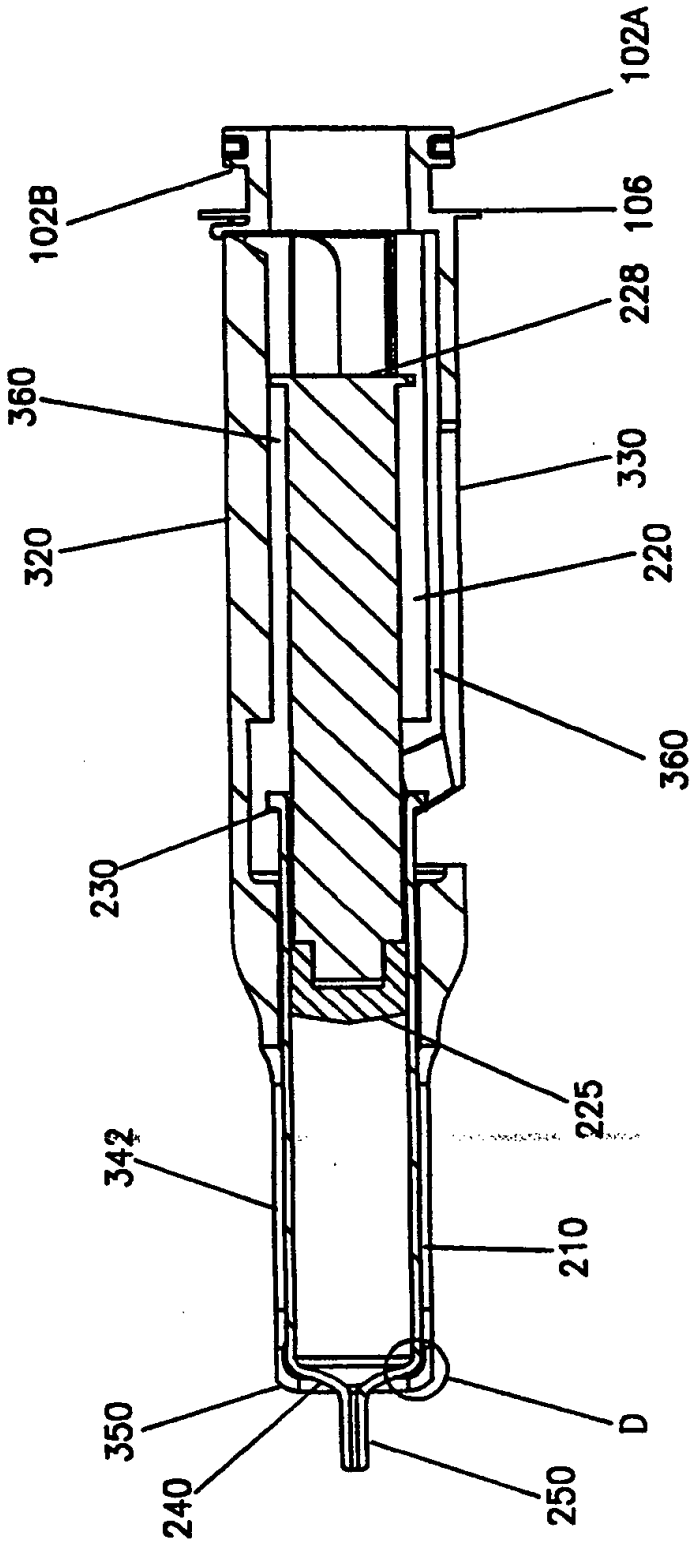


FIG. 3D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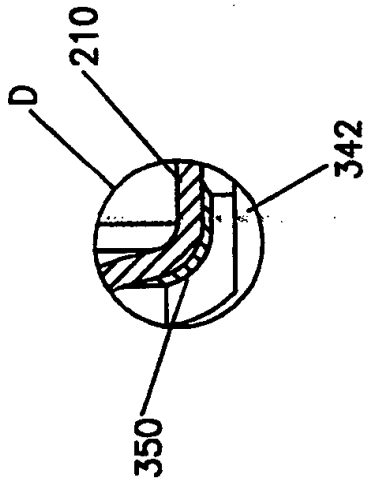
250


D
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342
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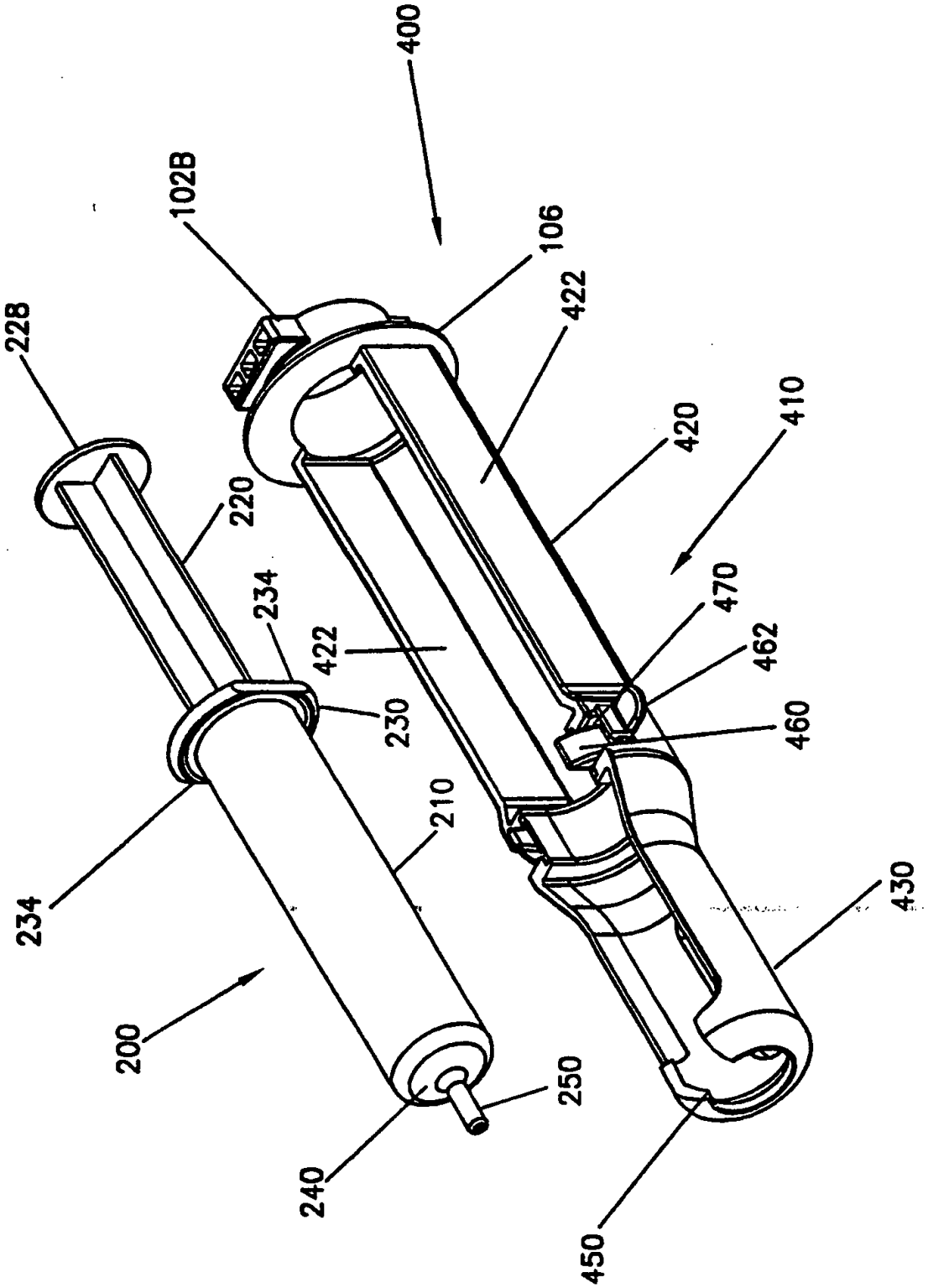
FIG. 3E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102B
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220
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422
462
230
460
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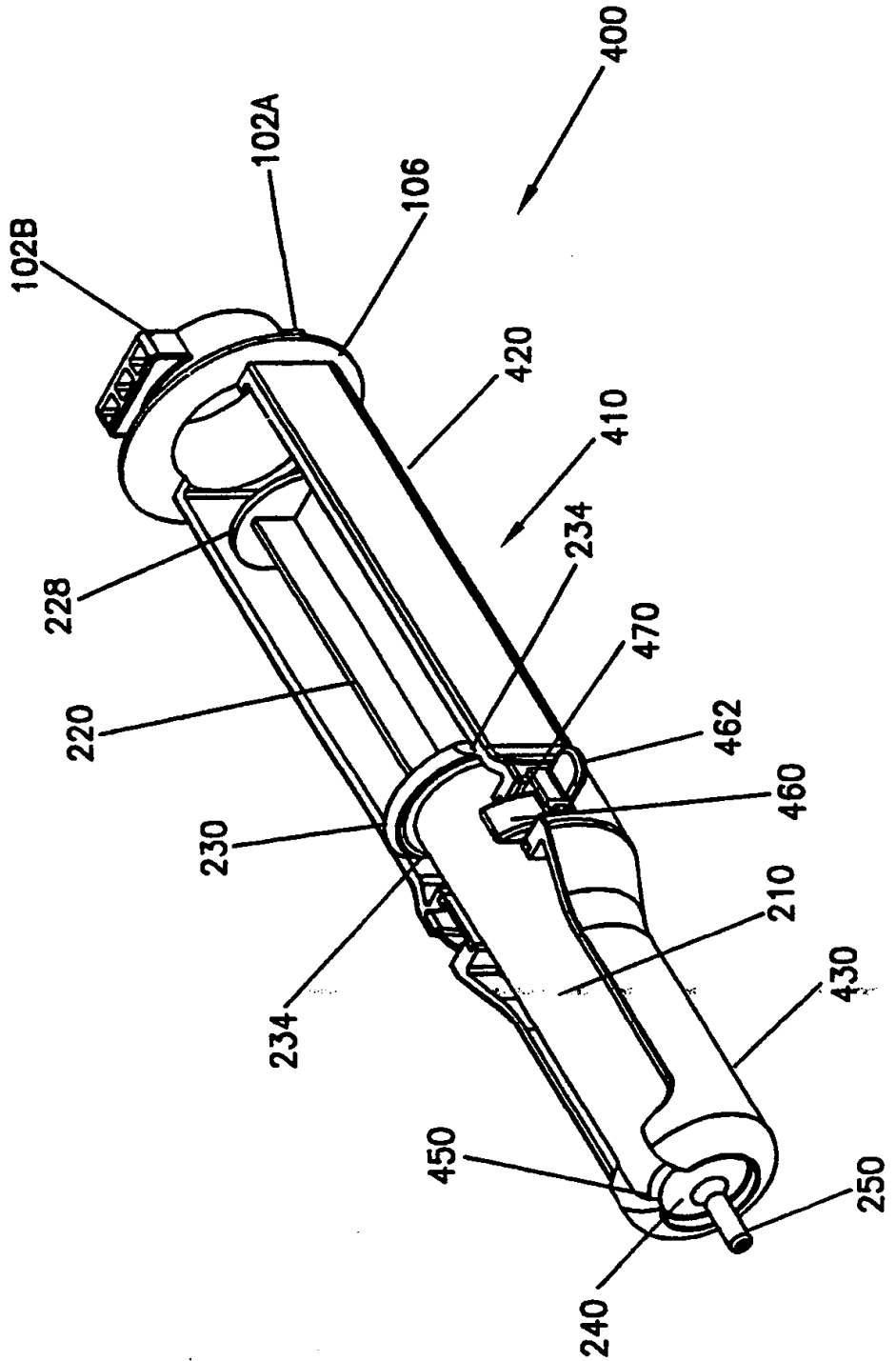
234
430
200
250
240
450

FIG. 4A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410
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228
470
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462
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234
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450
250
240

FIG. 4B

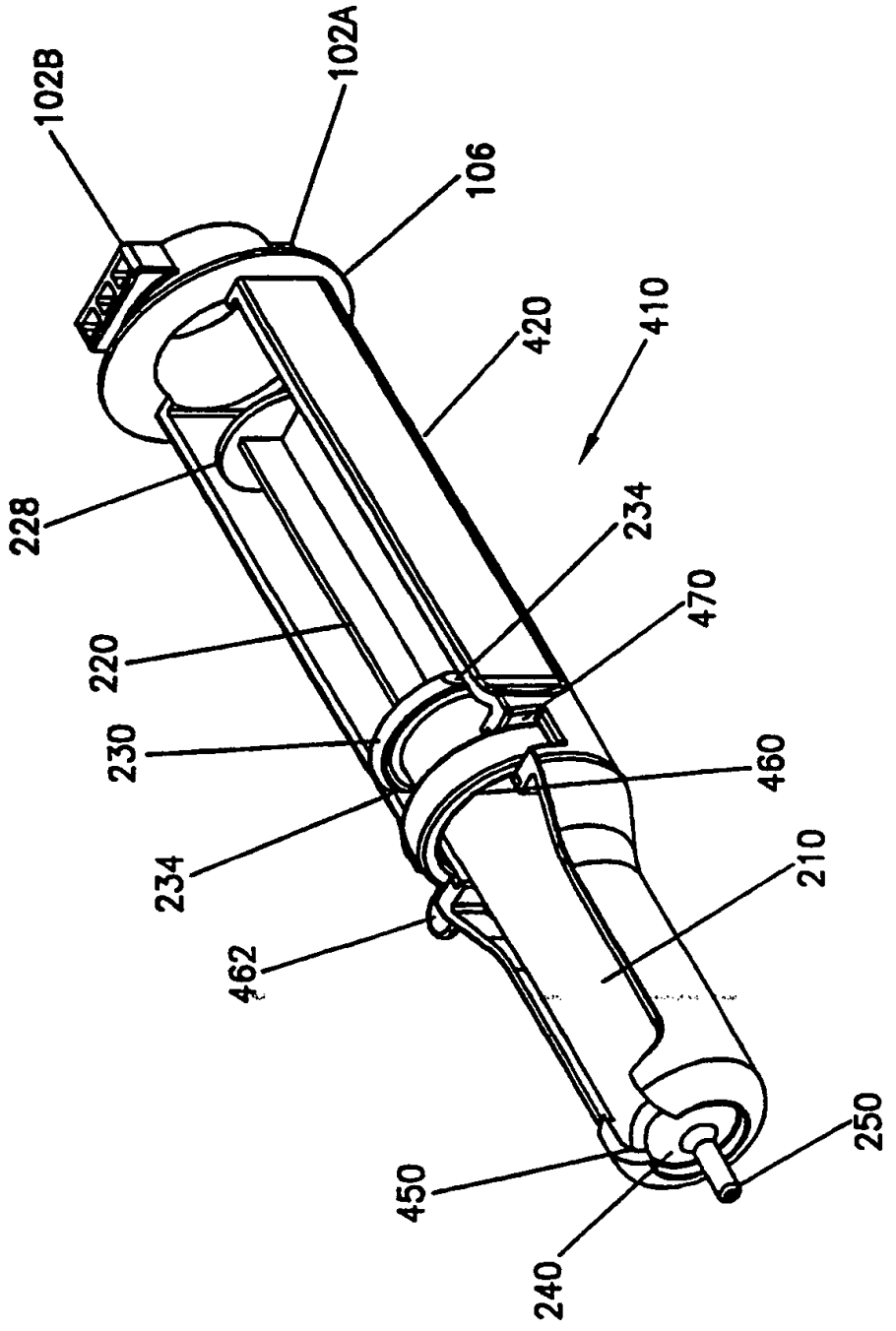
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FIG. 4C

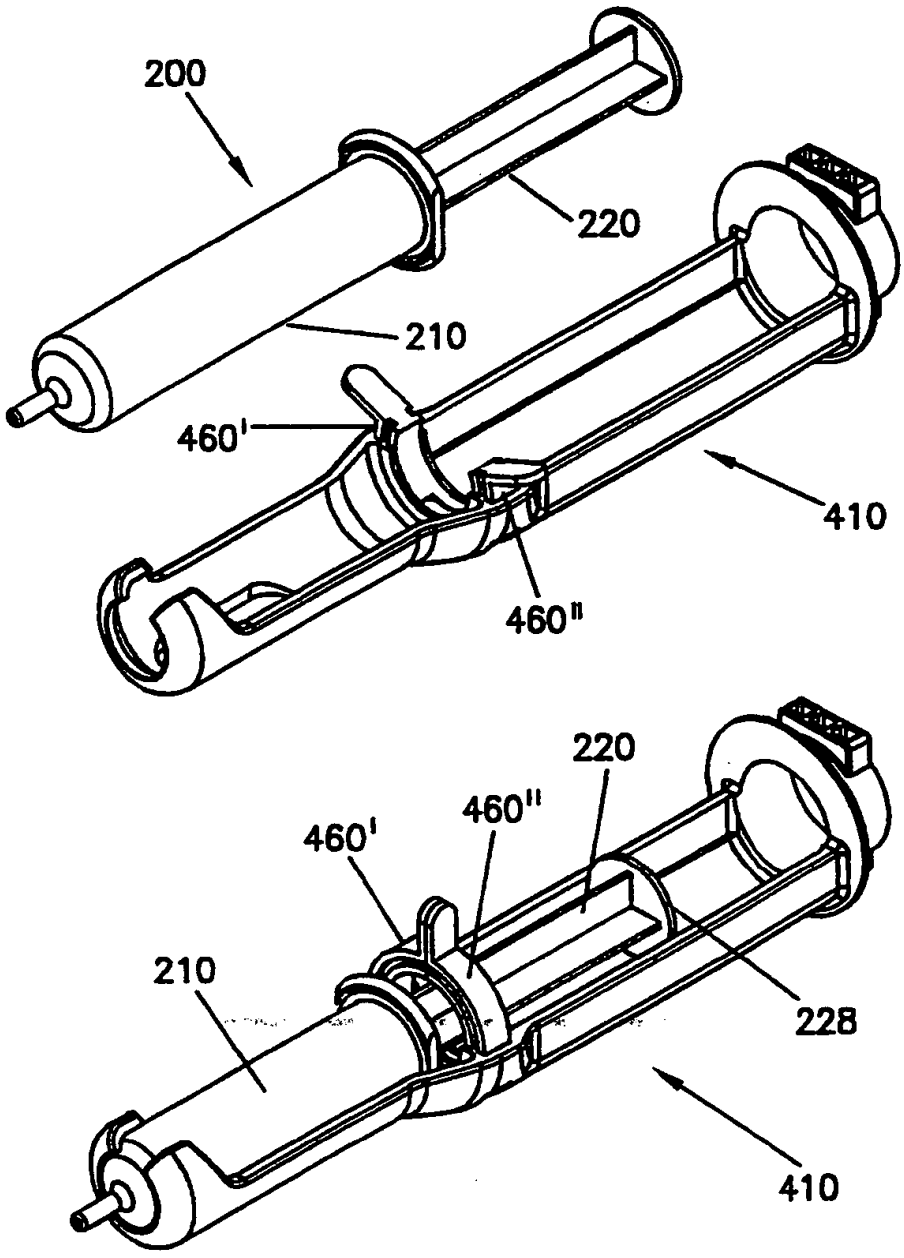
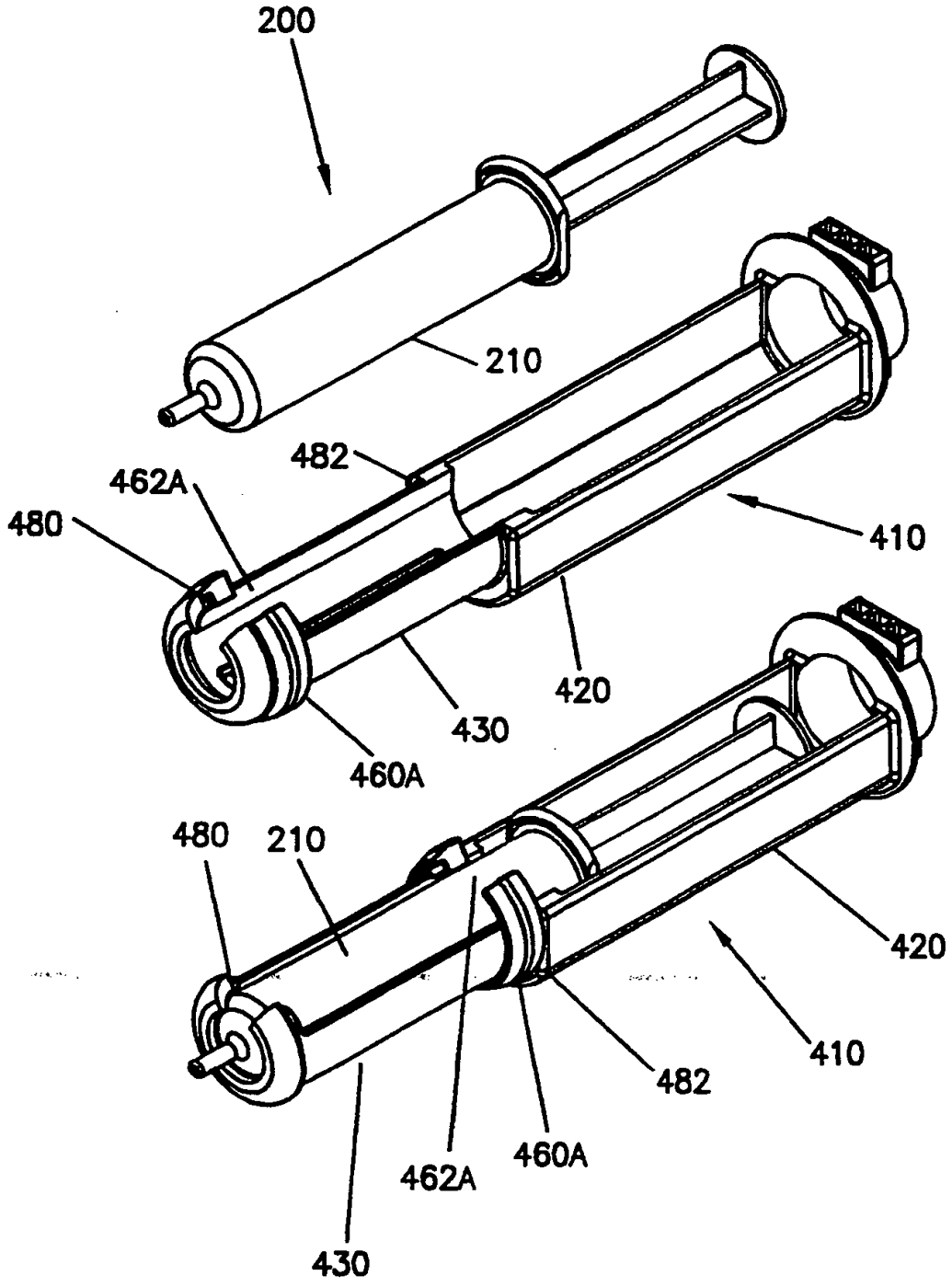


FIG. 4D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460A
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210
420
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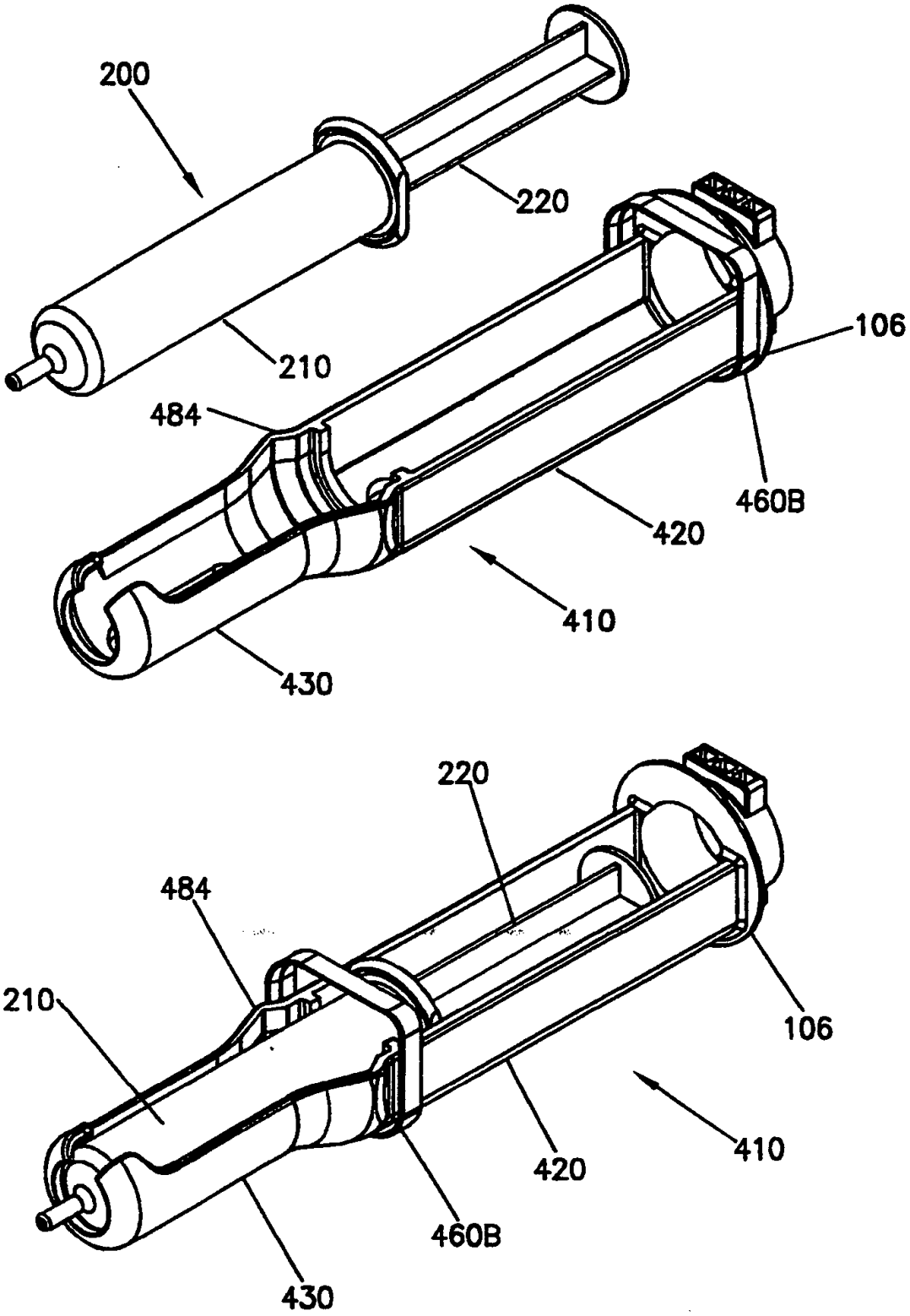
482
460A
462A
430

FIG. 4E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460B
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FIG. 4F

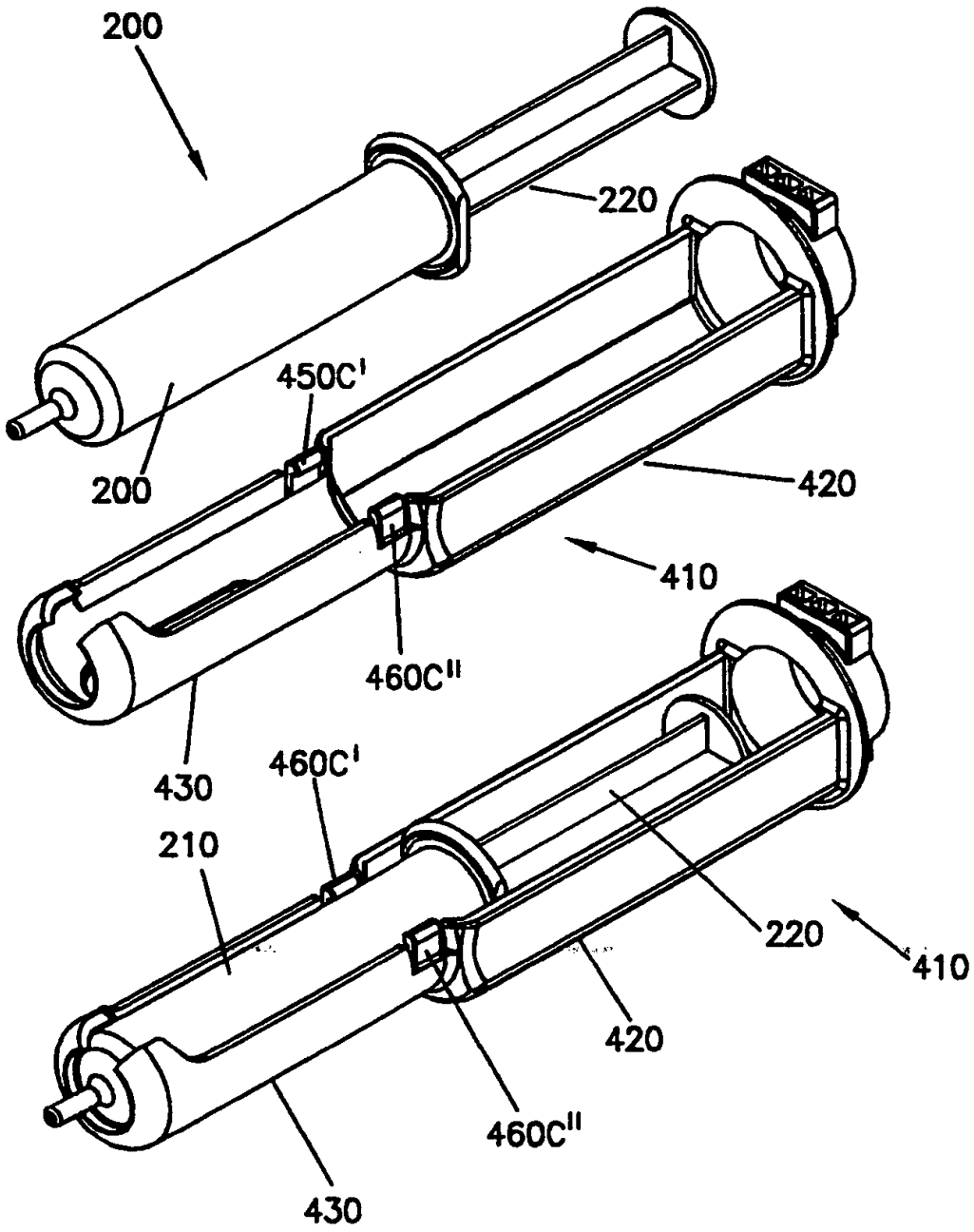


FIG. 4G

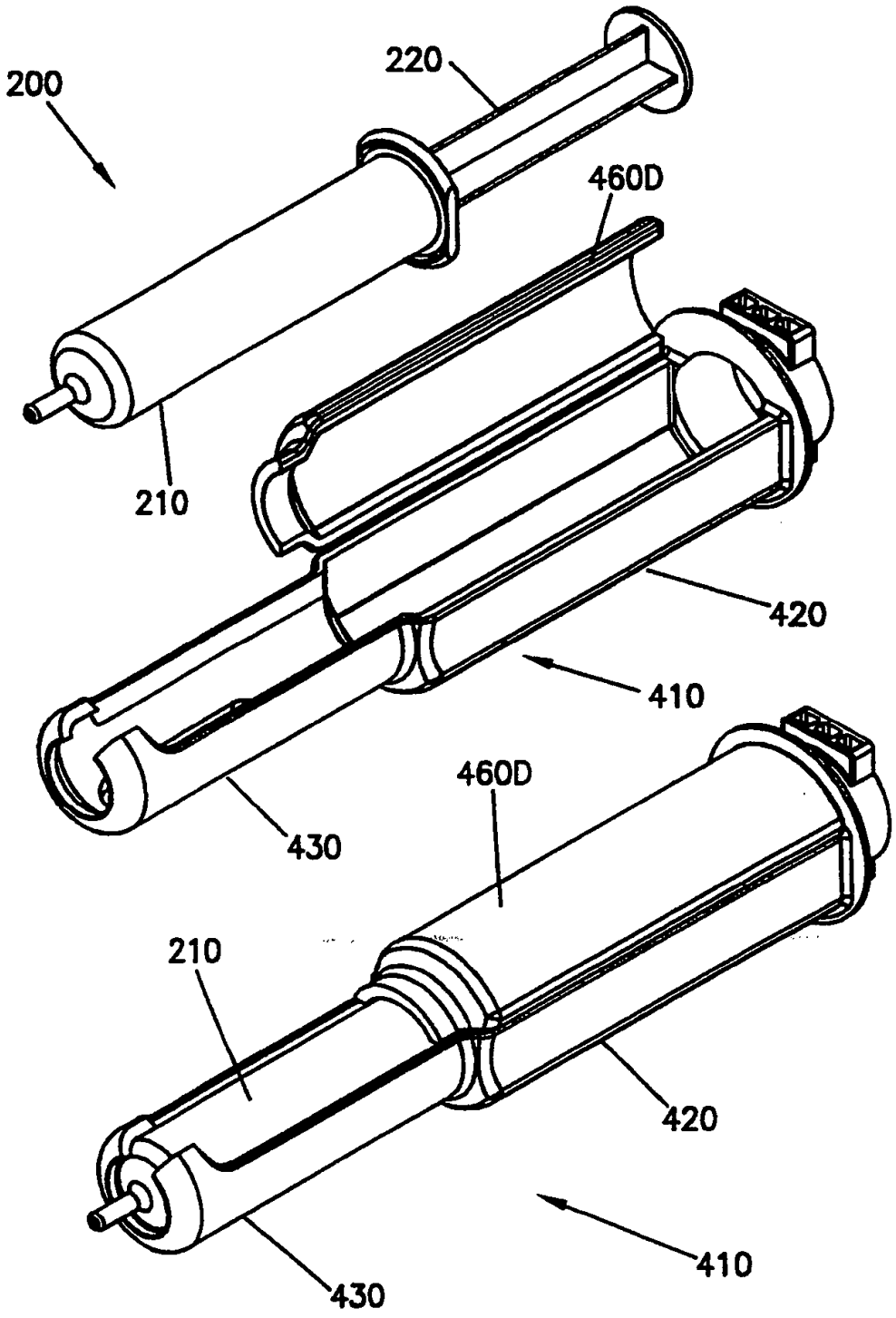
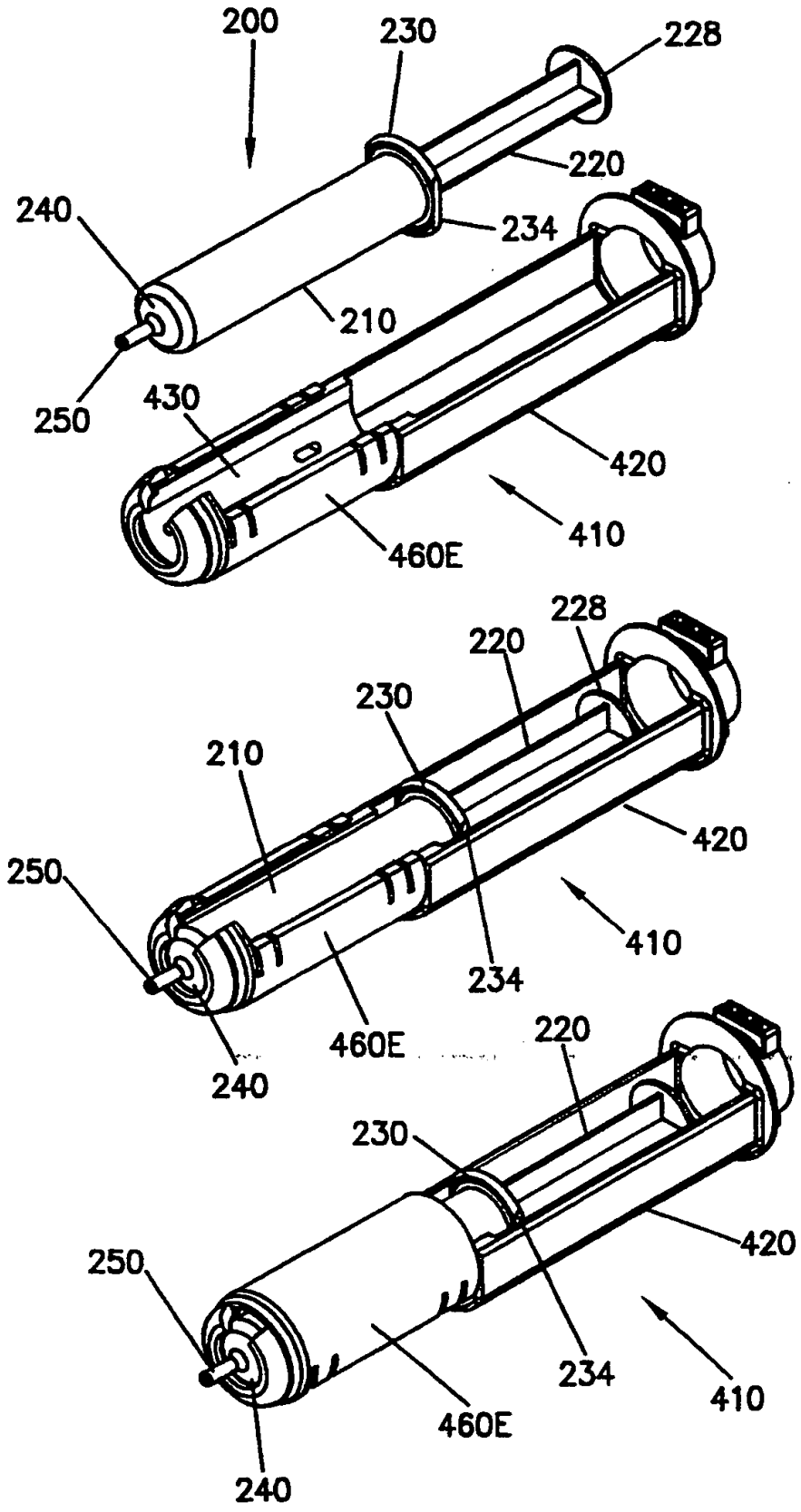


FIG. 4H


200
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420
410
460E
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460E
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420
250
234
410
460E
240

FIG. 4I

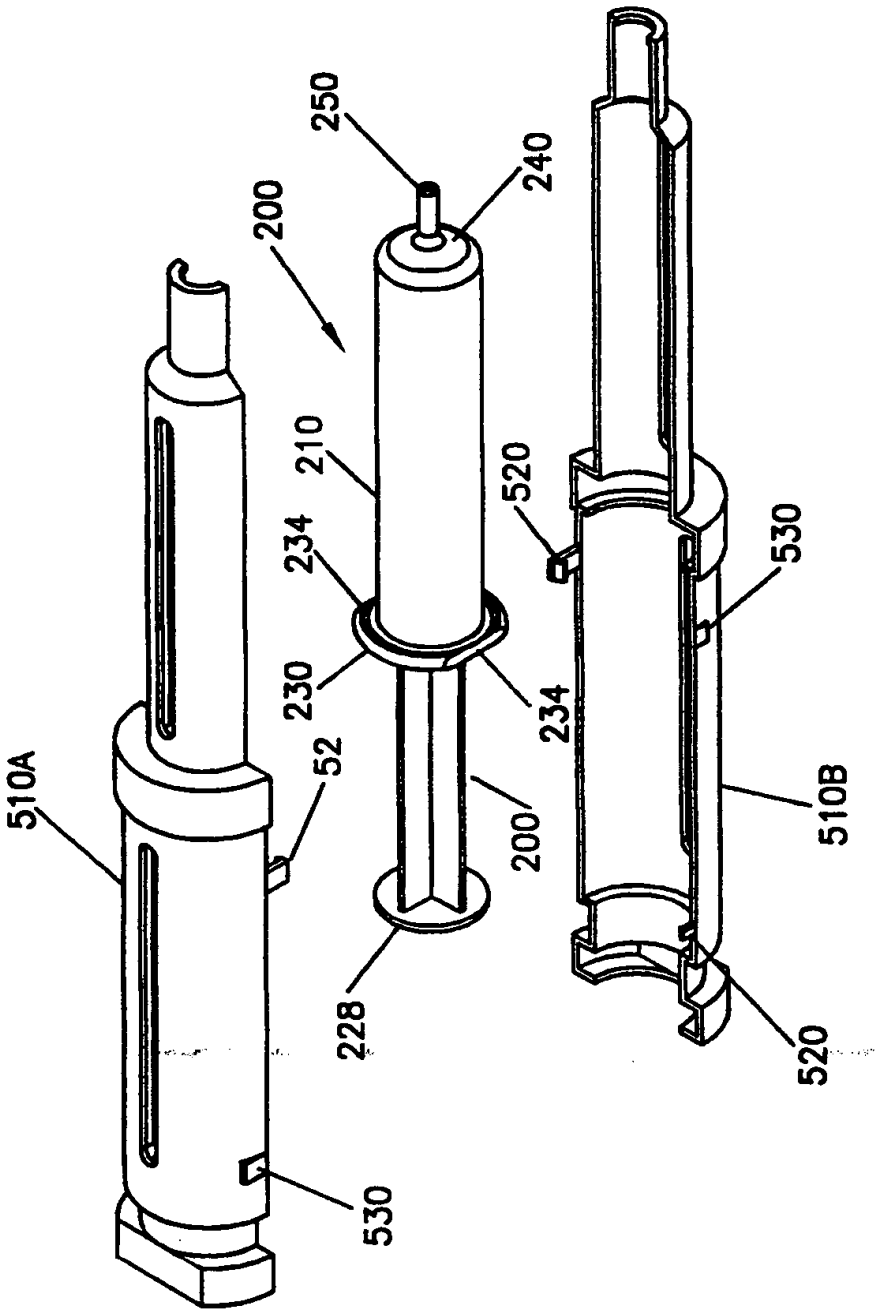


FIG. 5A

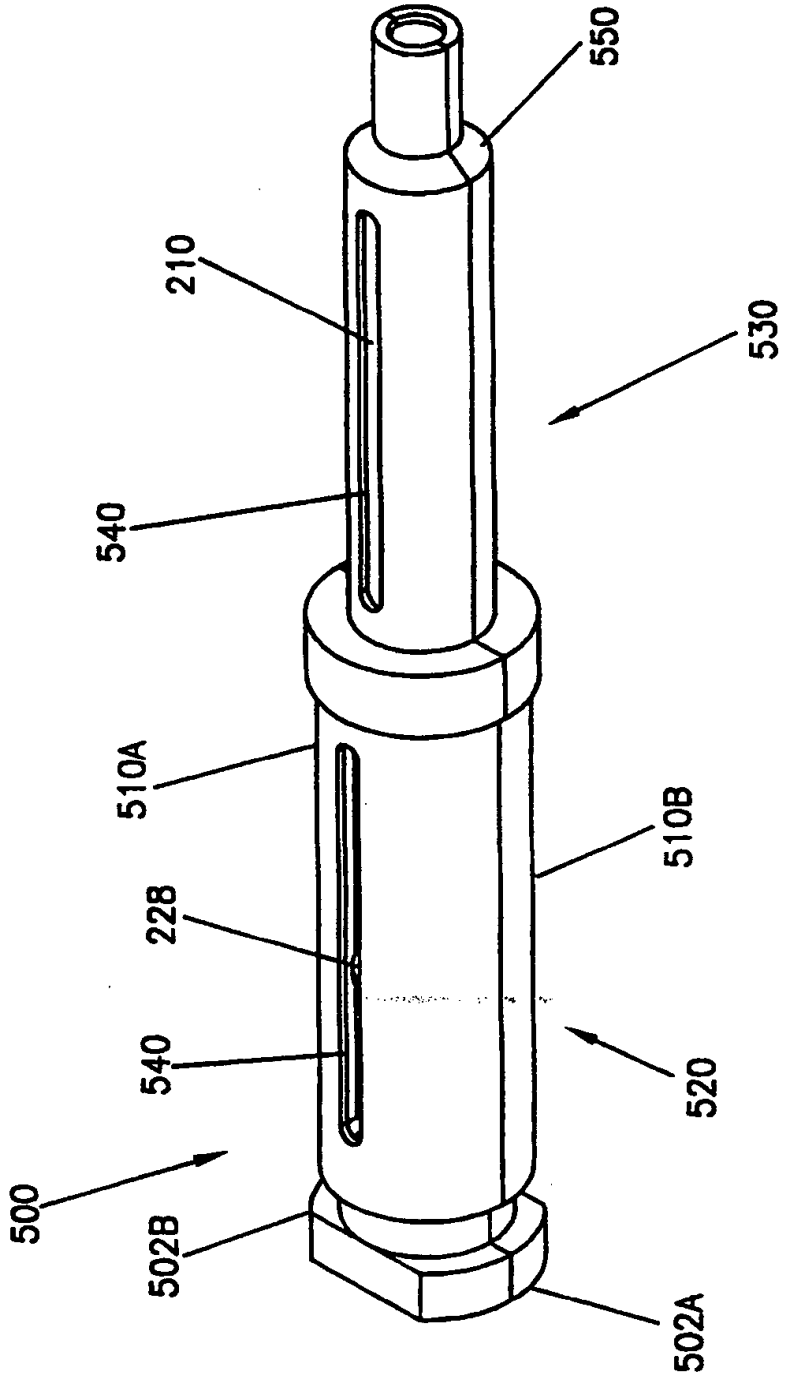


FIG. 5B

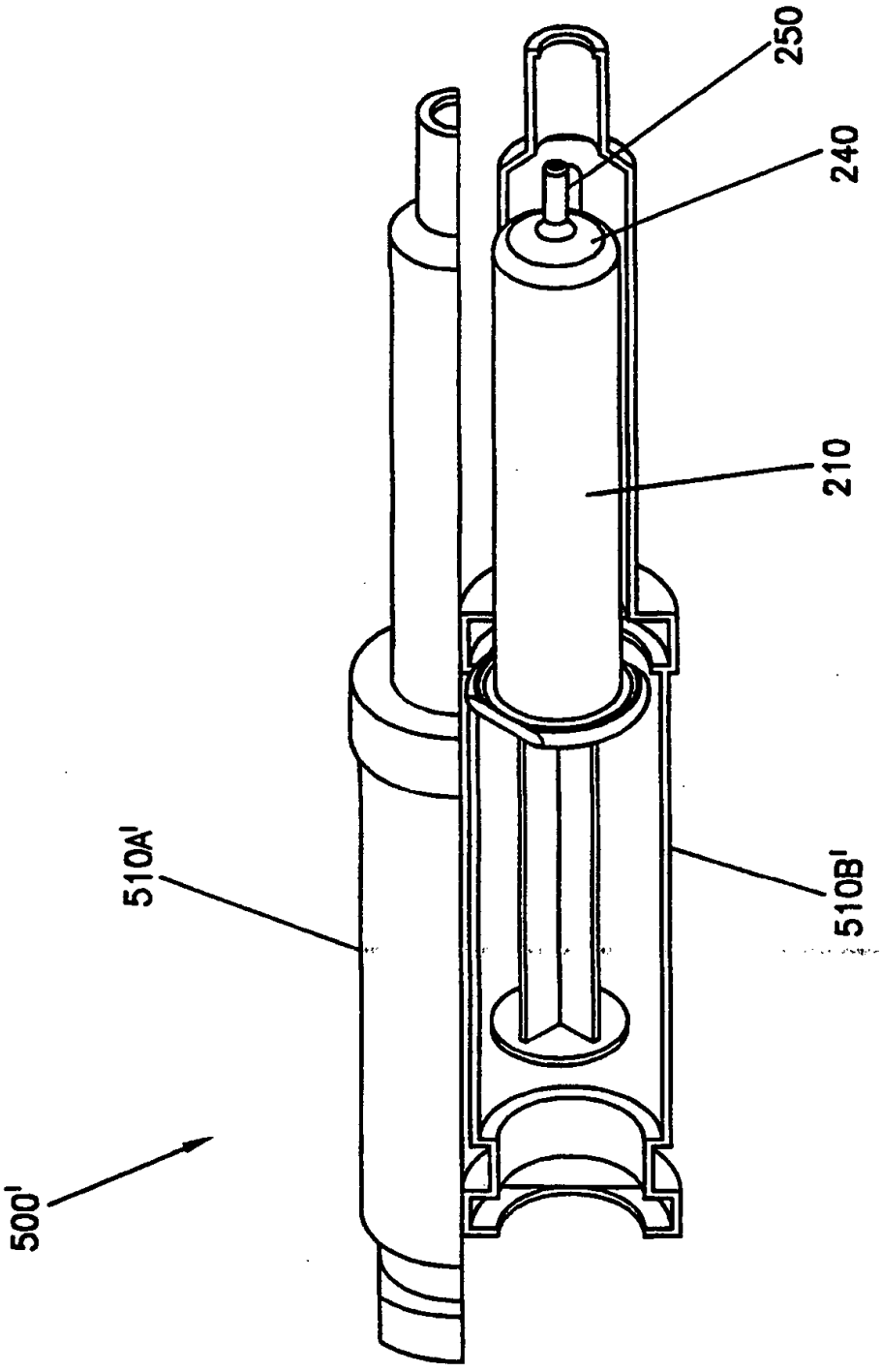


FIG. 6A

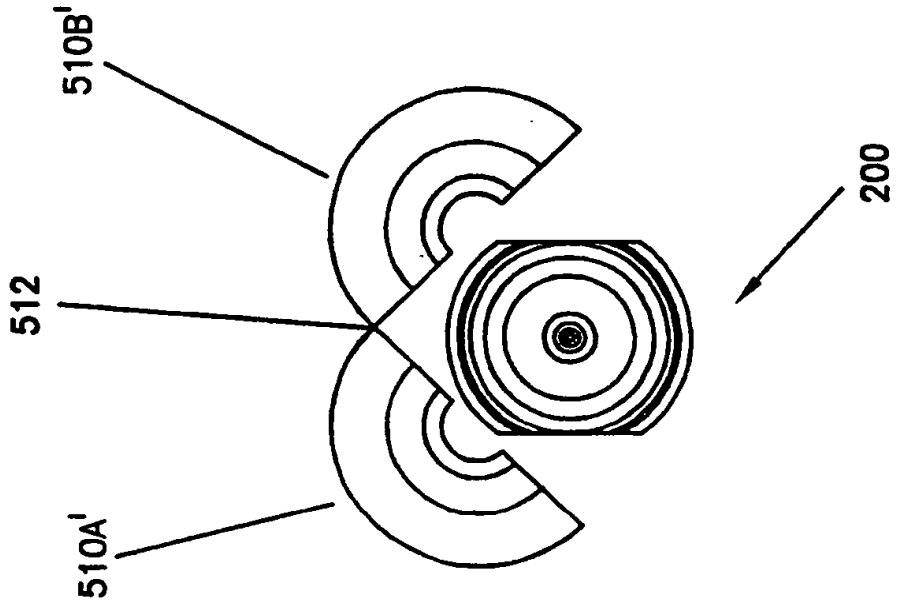


FIG. 6B

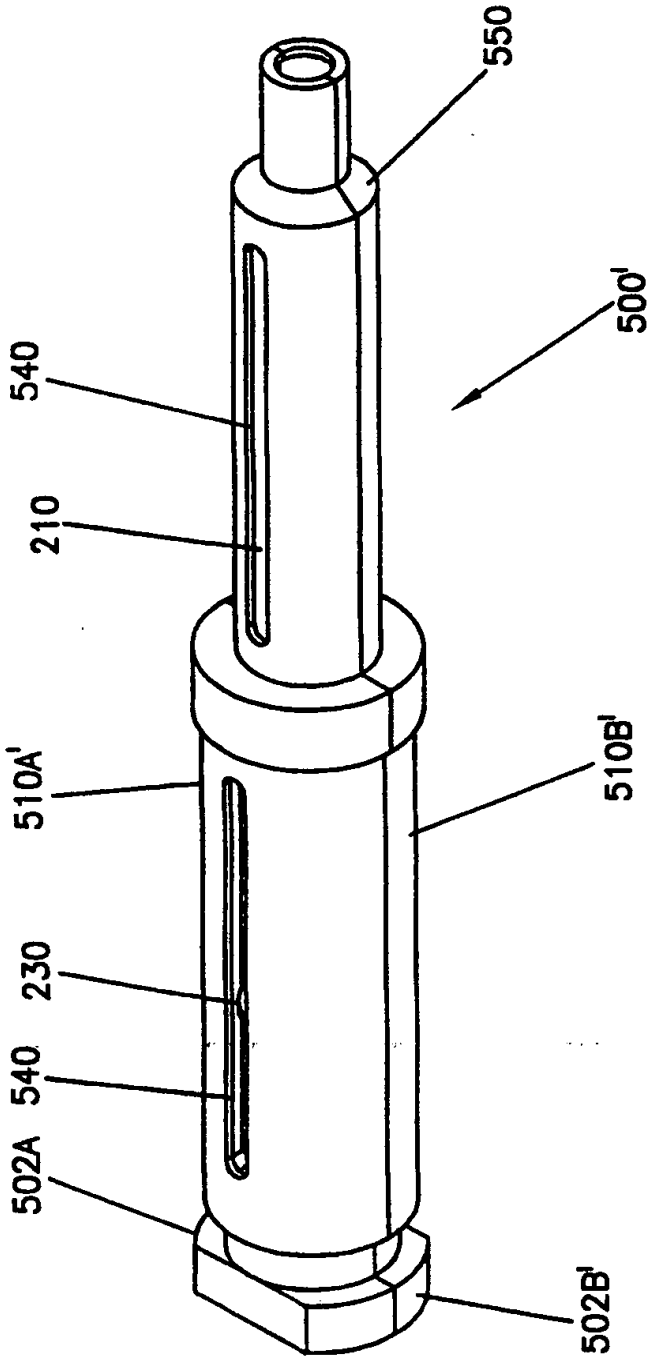
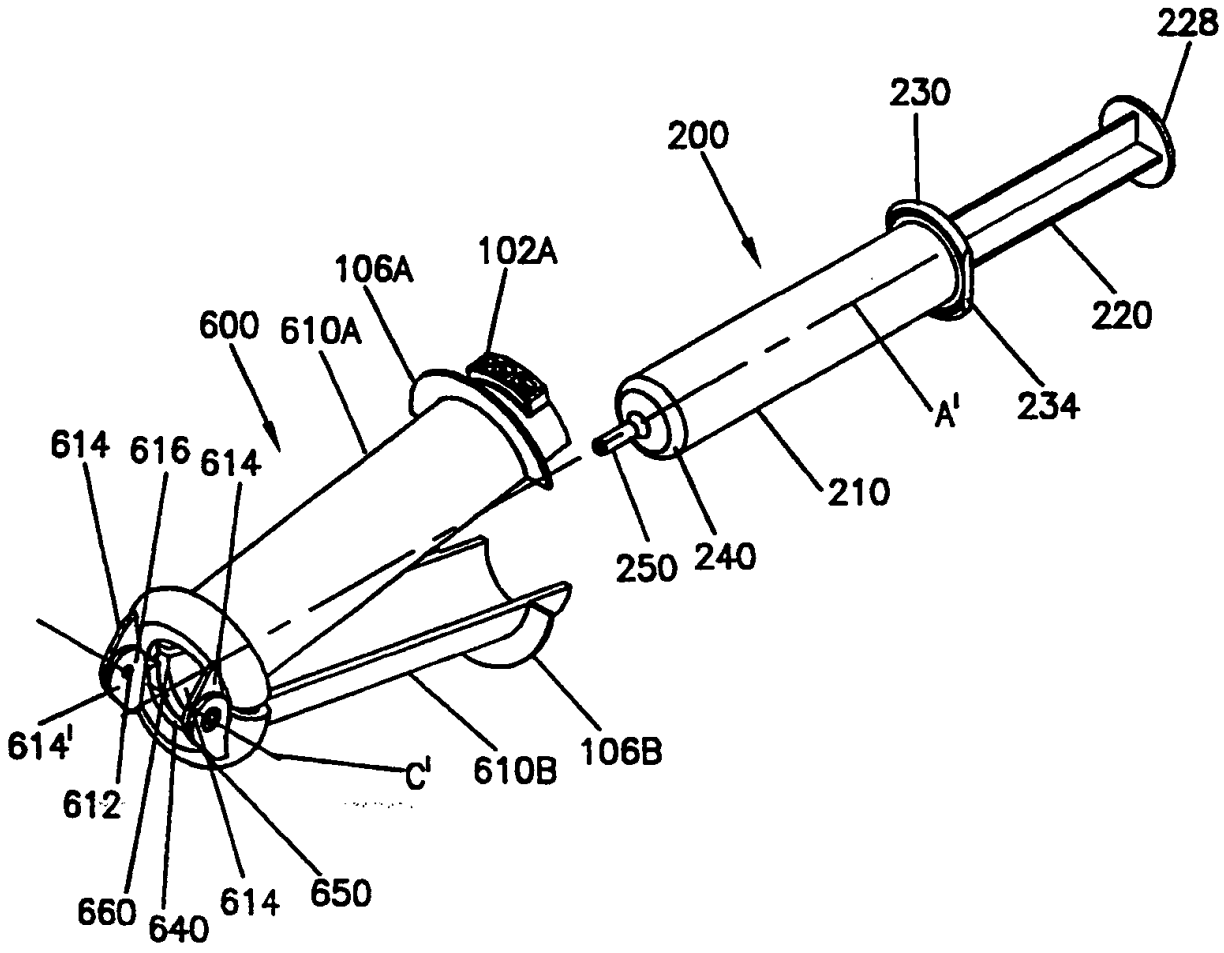


FIG. 6C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200
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102A
600
610A
220
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A'
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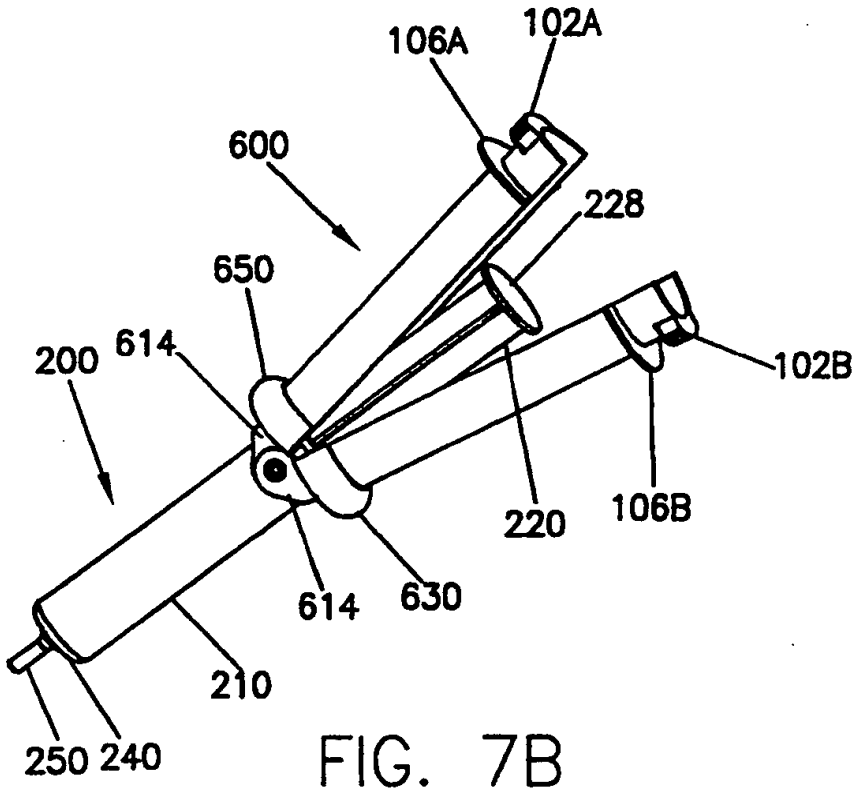
240
614'
612
C'
610B
106B
660
640
614
650

FIG. 7A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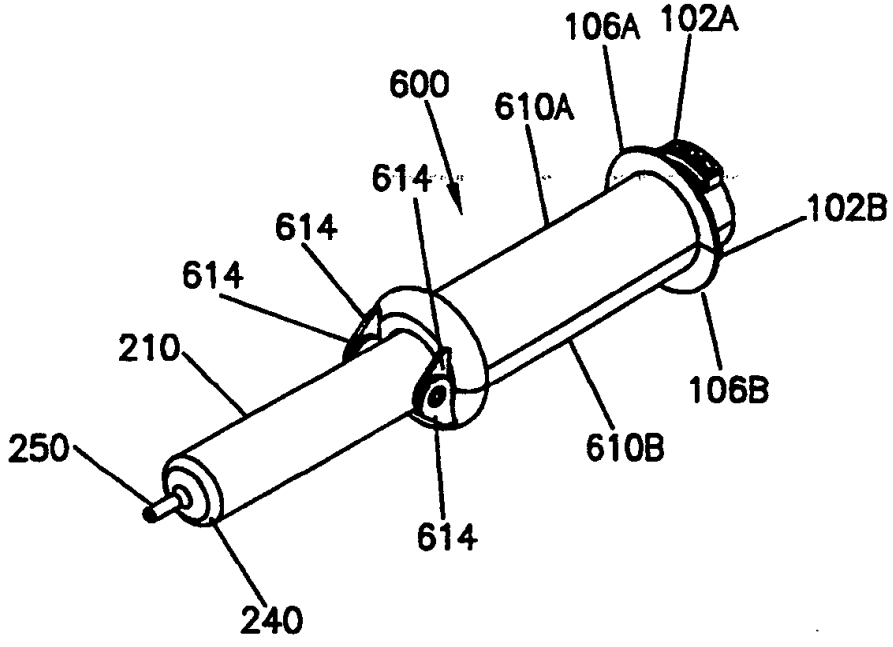
102A
600
228
650
200
614
102B
220
106B
614
630
210
250
240

FIG. 7B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102A
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610A
614
614
102B
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210
106B
610B
250
614
240

FIG. 7C

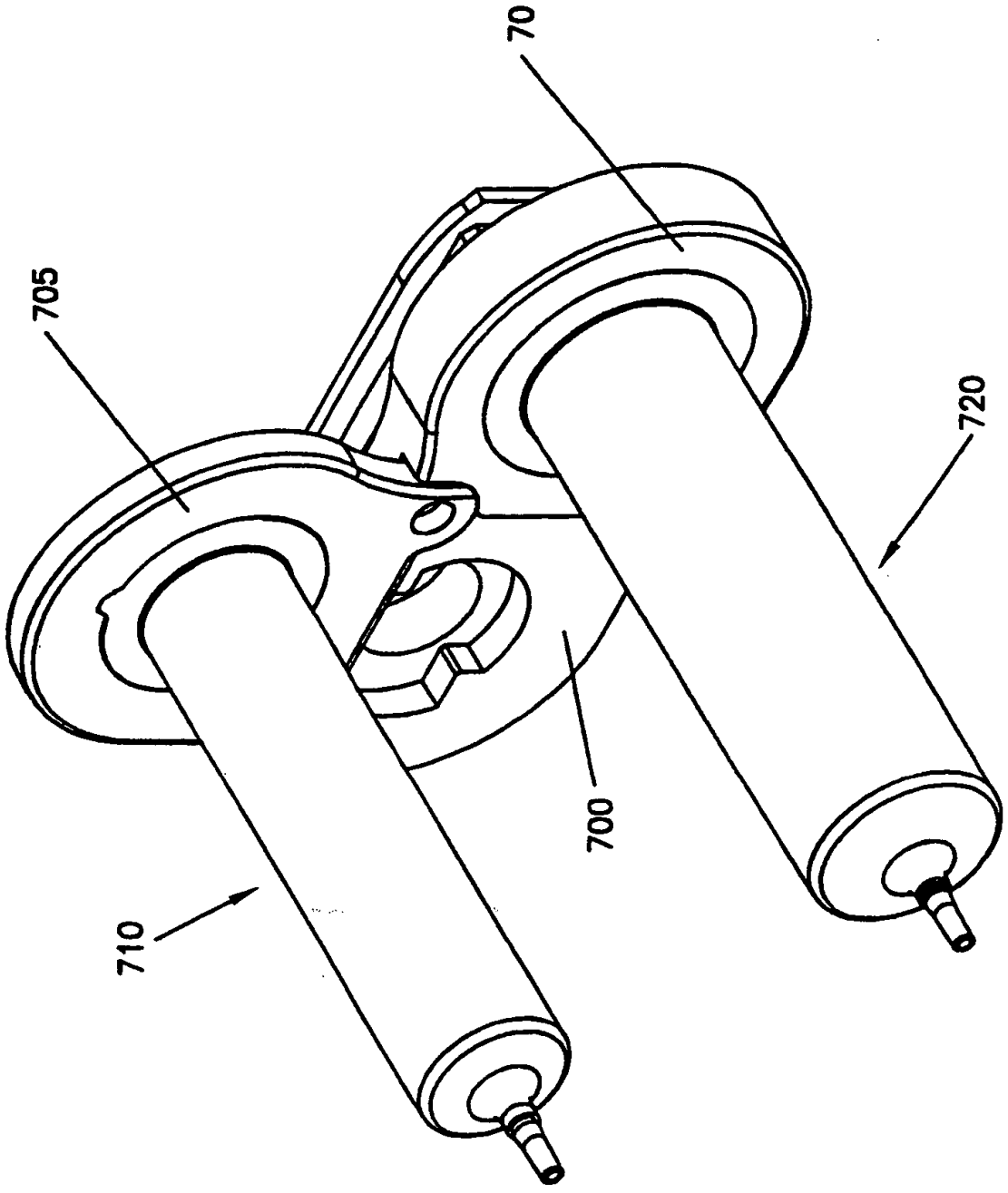


FIG. 8A

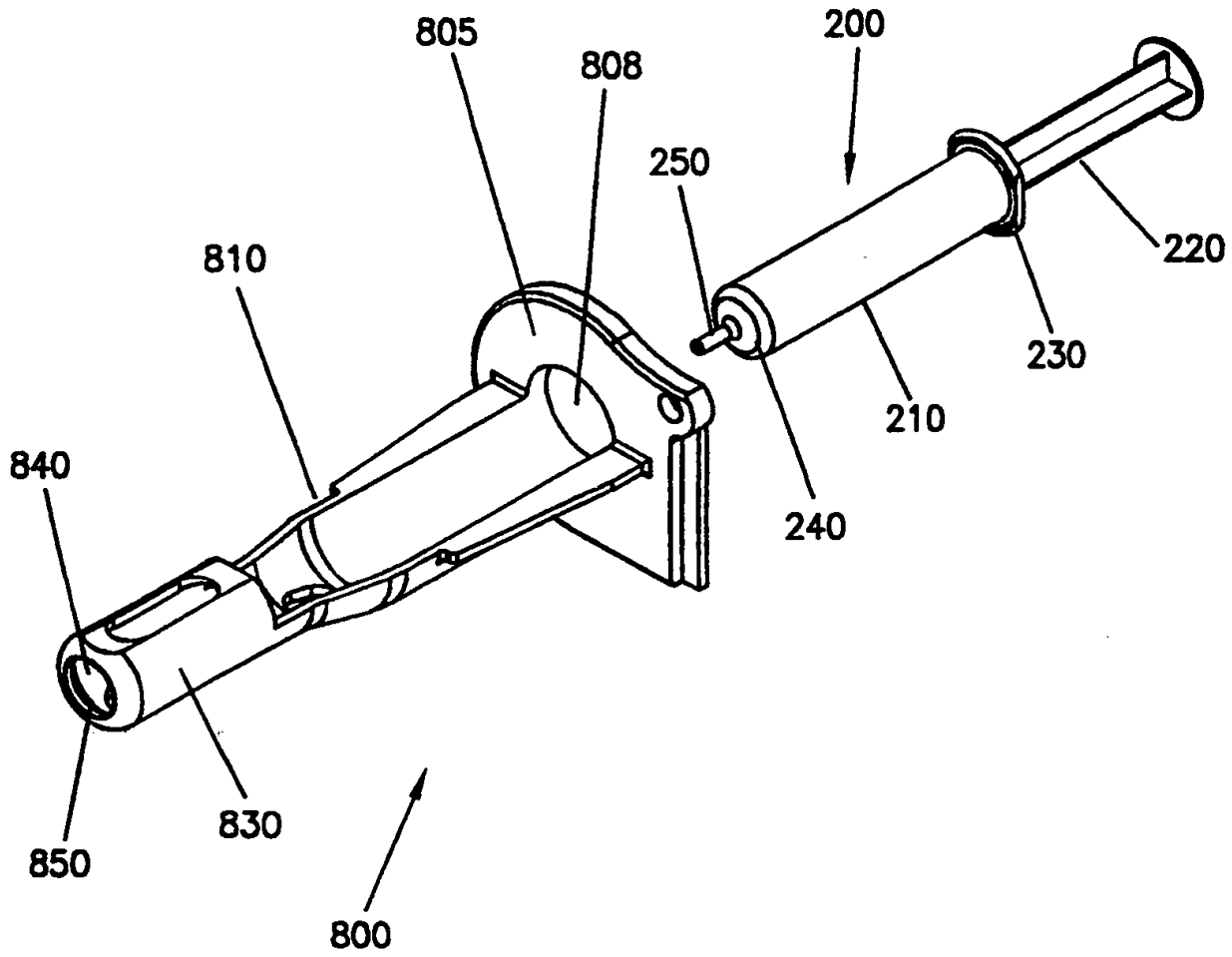


FIG. 8B

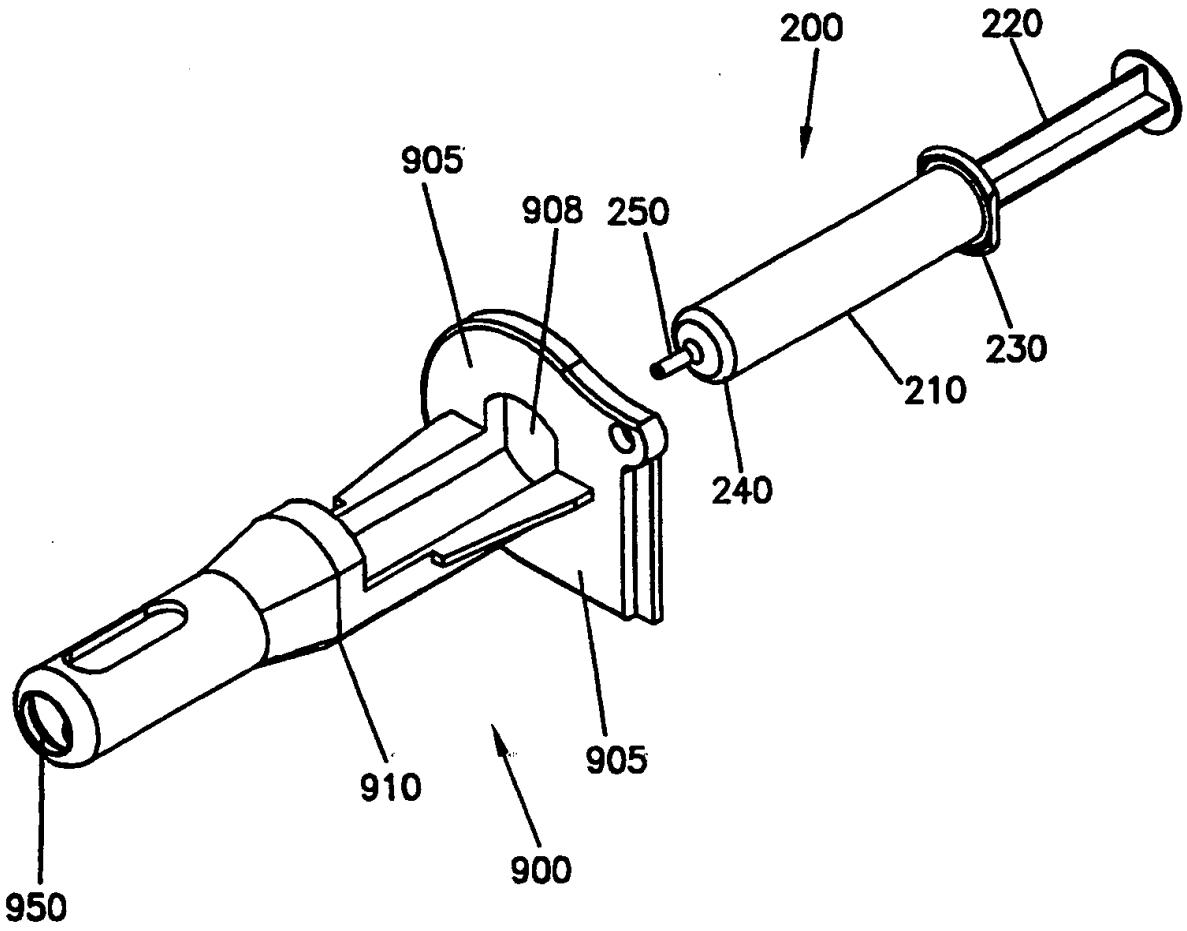


FIG. 8C

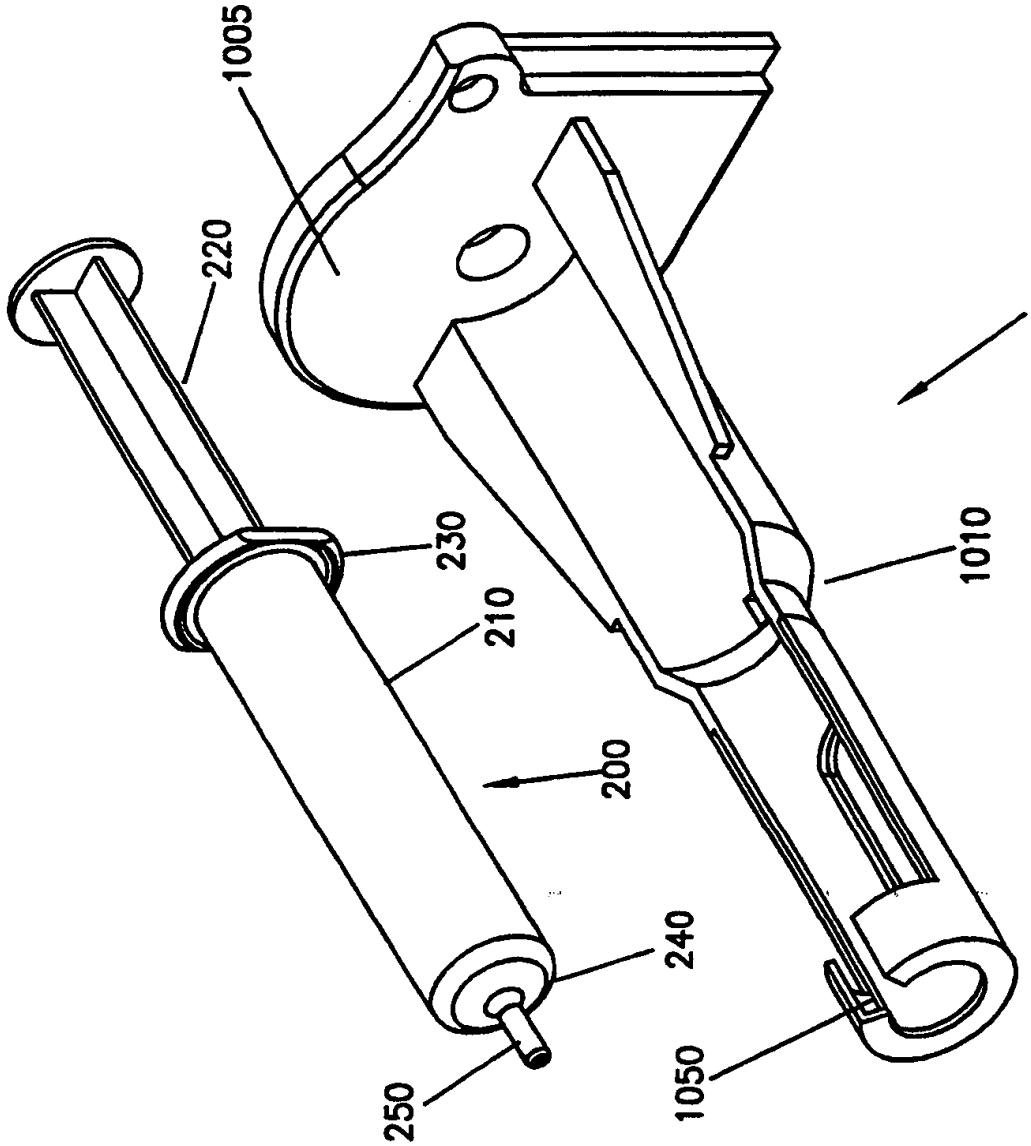


FIG. 8D

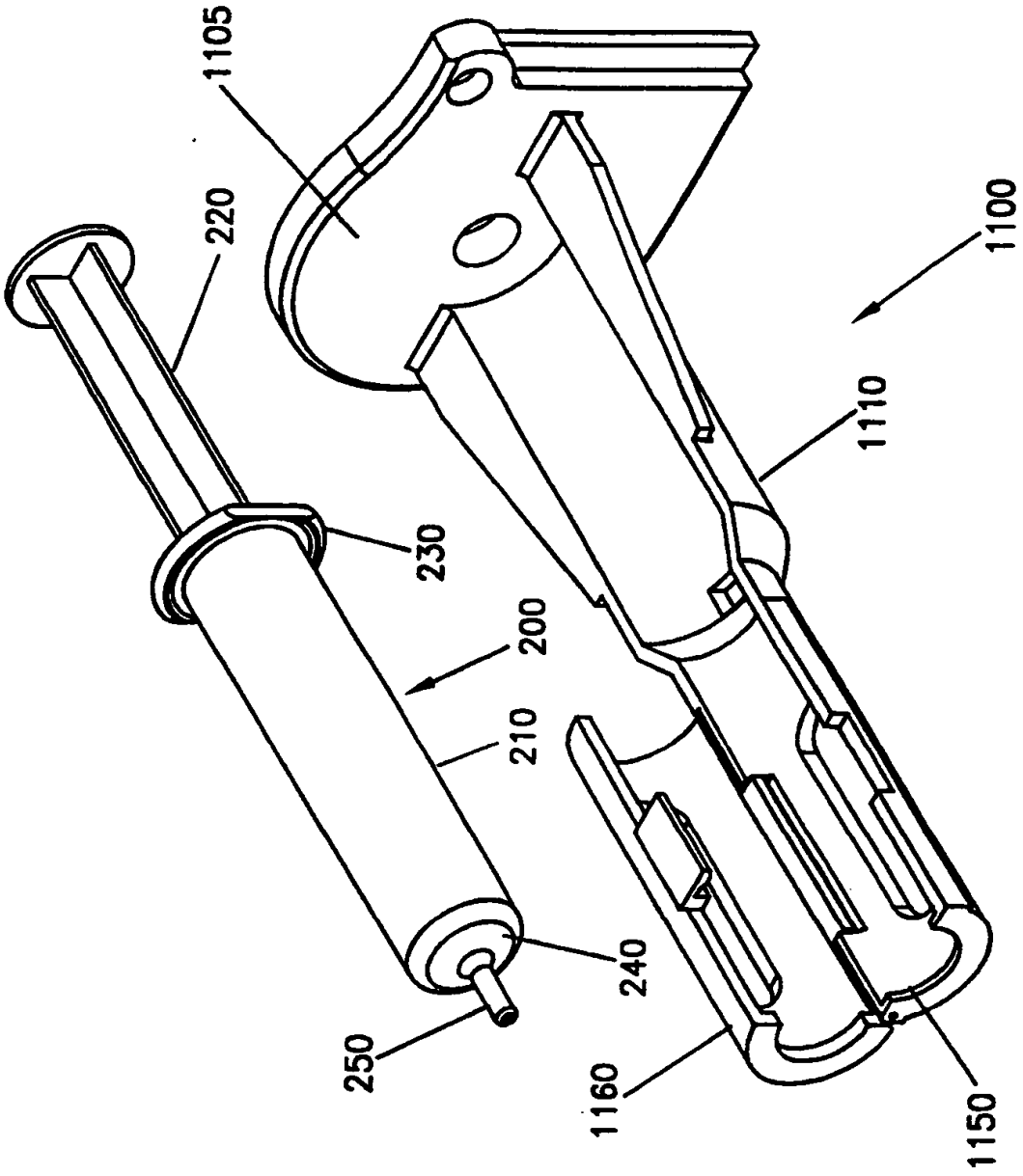


FIG. 8E

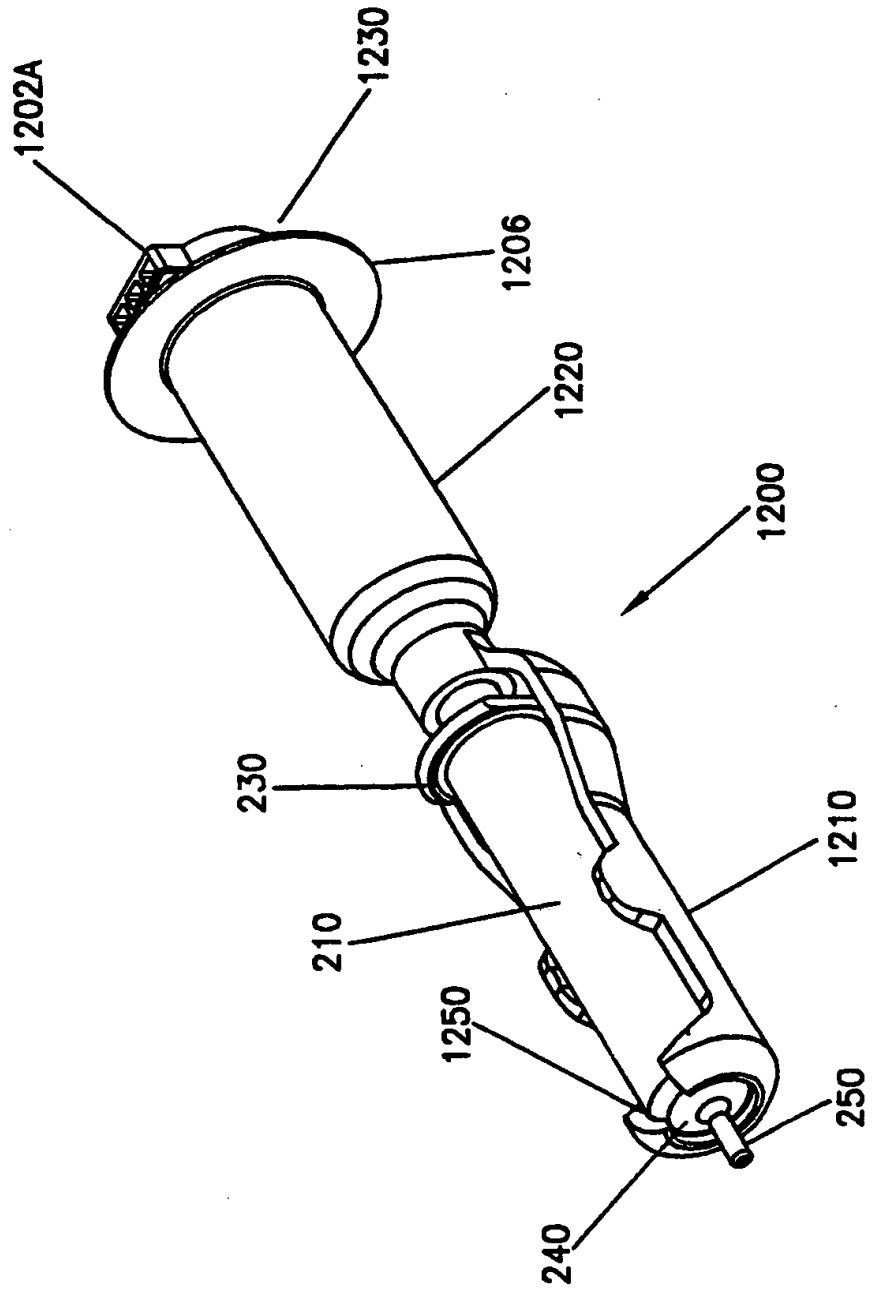
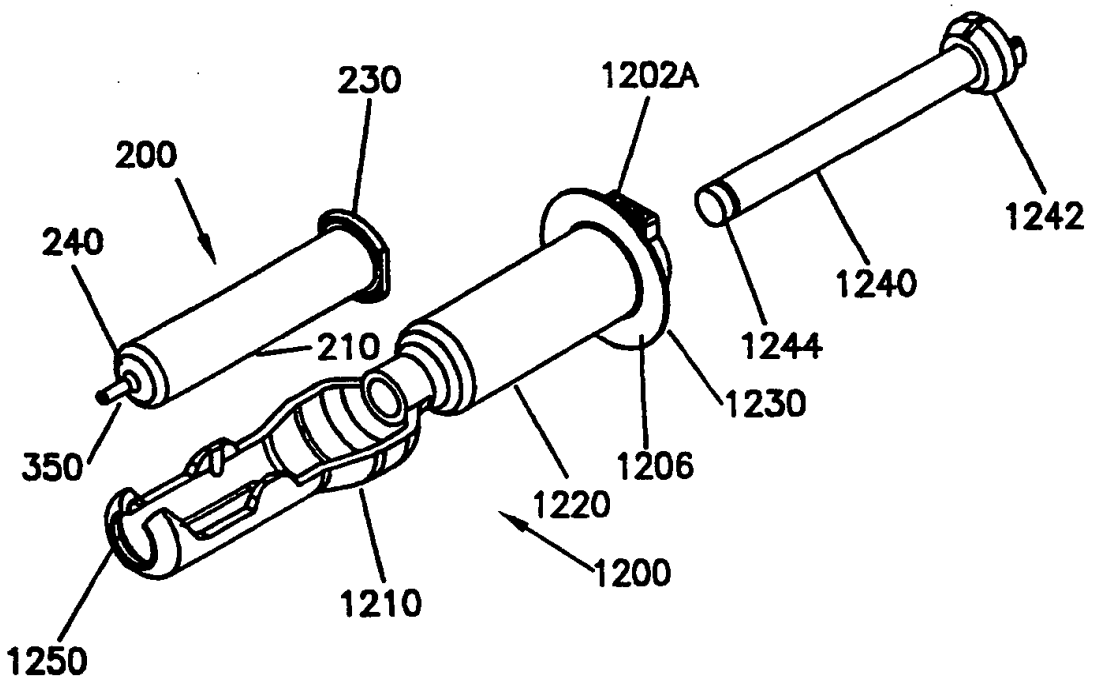


FIG. 9A


230
1202A
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1242
1240
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1244
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1206
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1210
1250

FIG. 9B

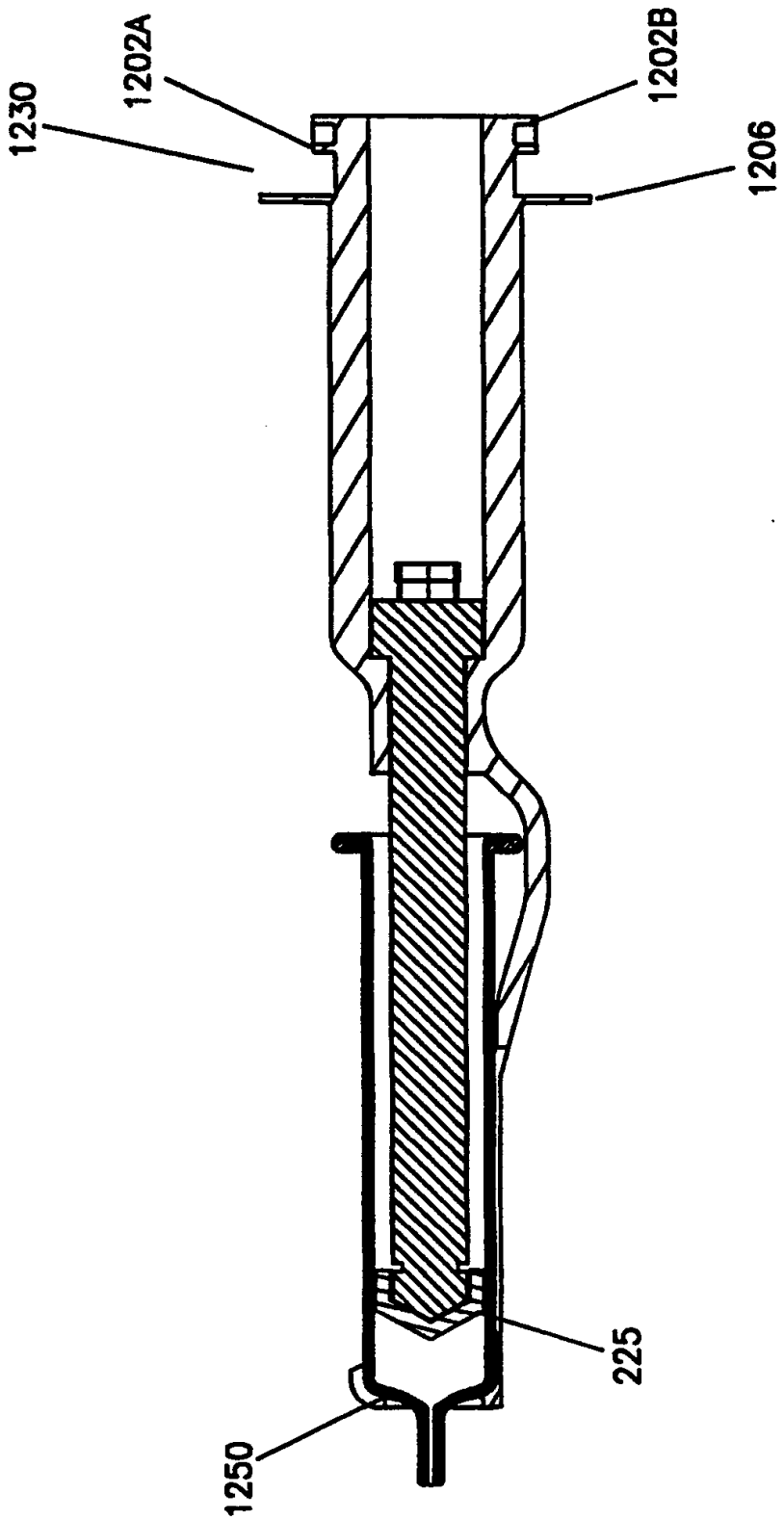

FIG. 9C

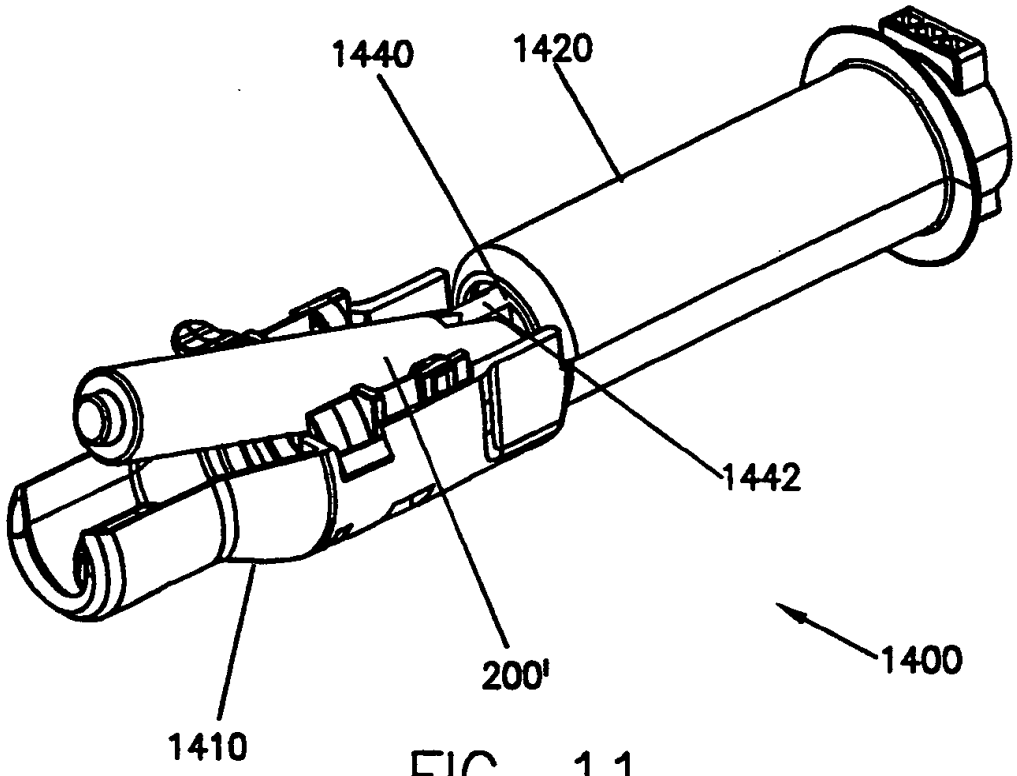

FIG. 11

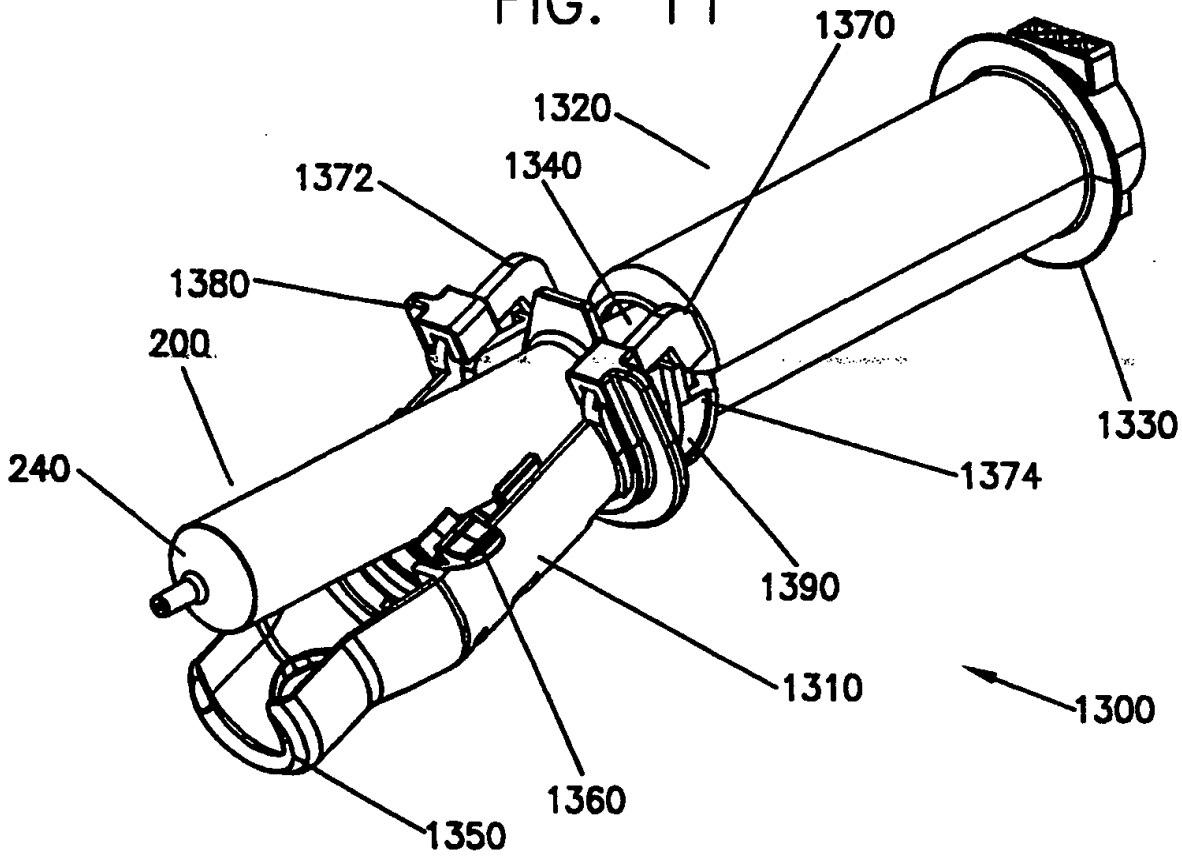

FIG. 10A

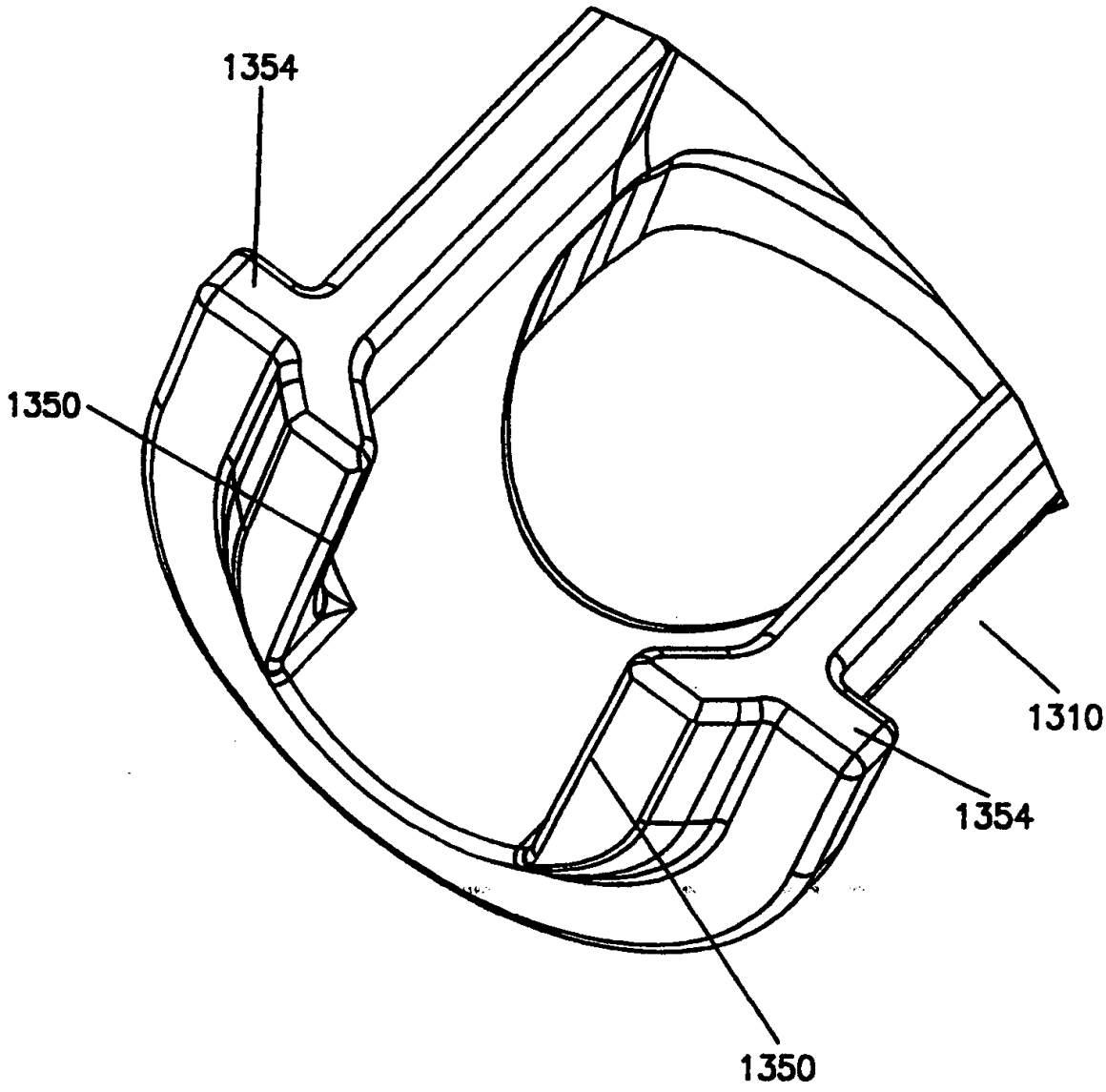

FIG. 10B

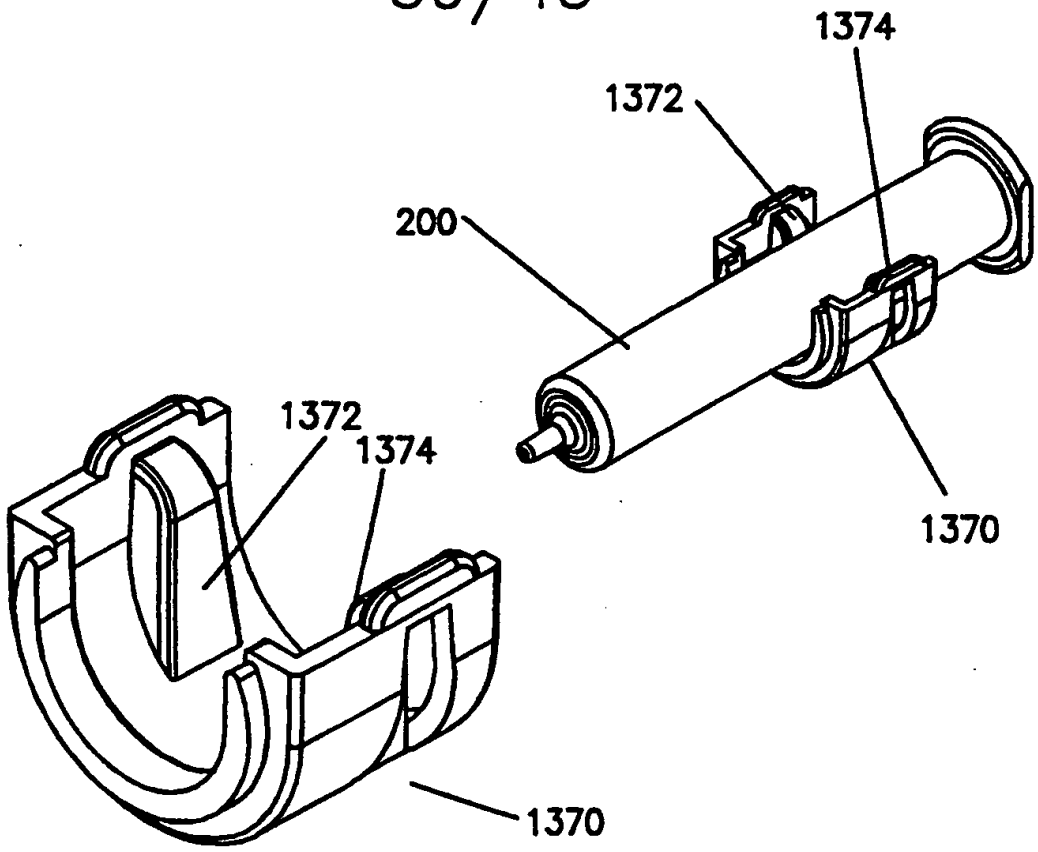

FIG. 10C

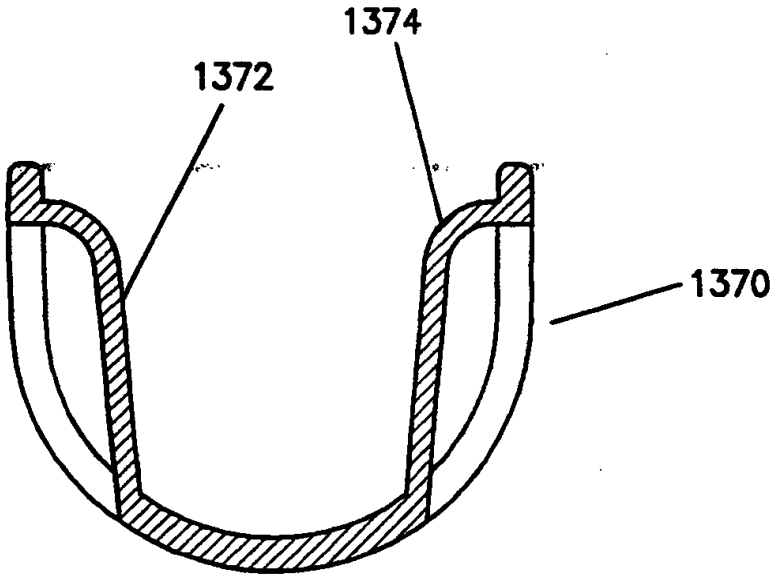

FIG. 10D

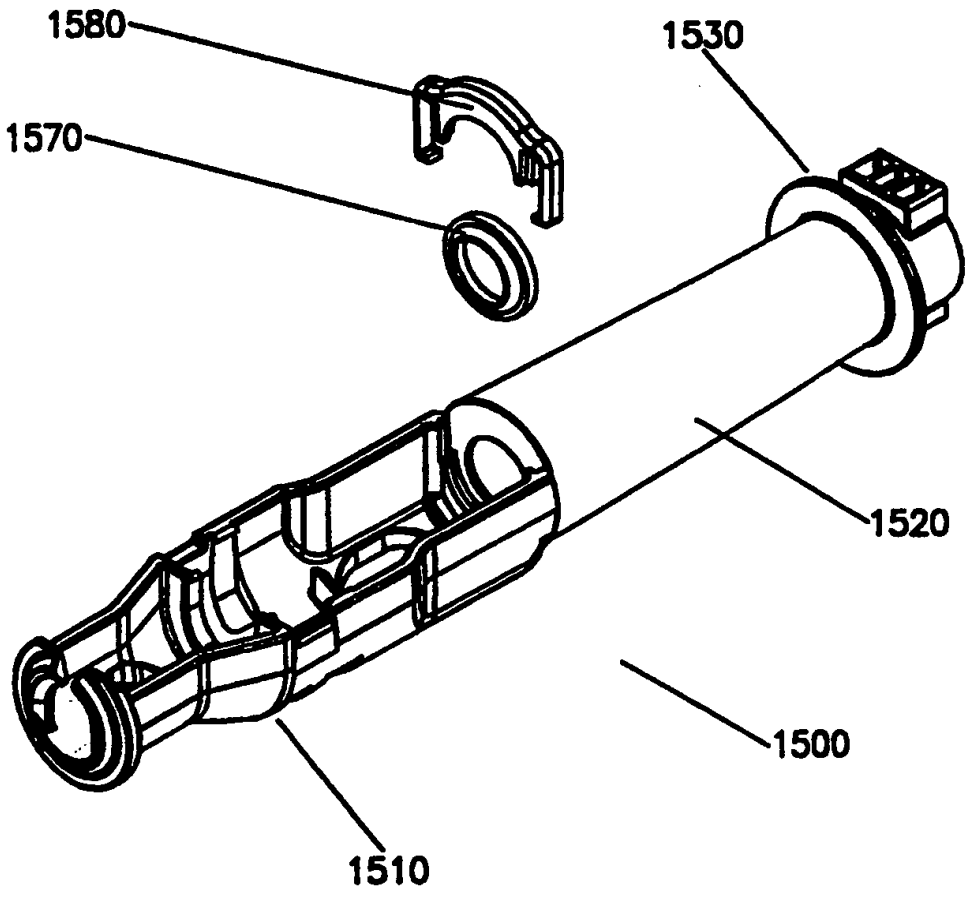

FIG. 12A

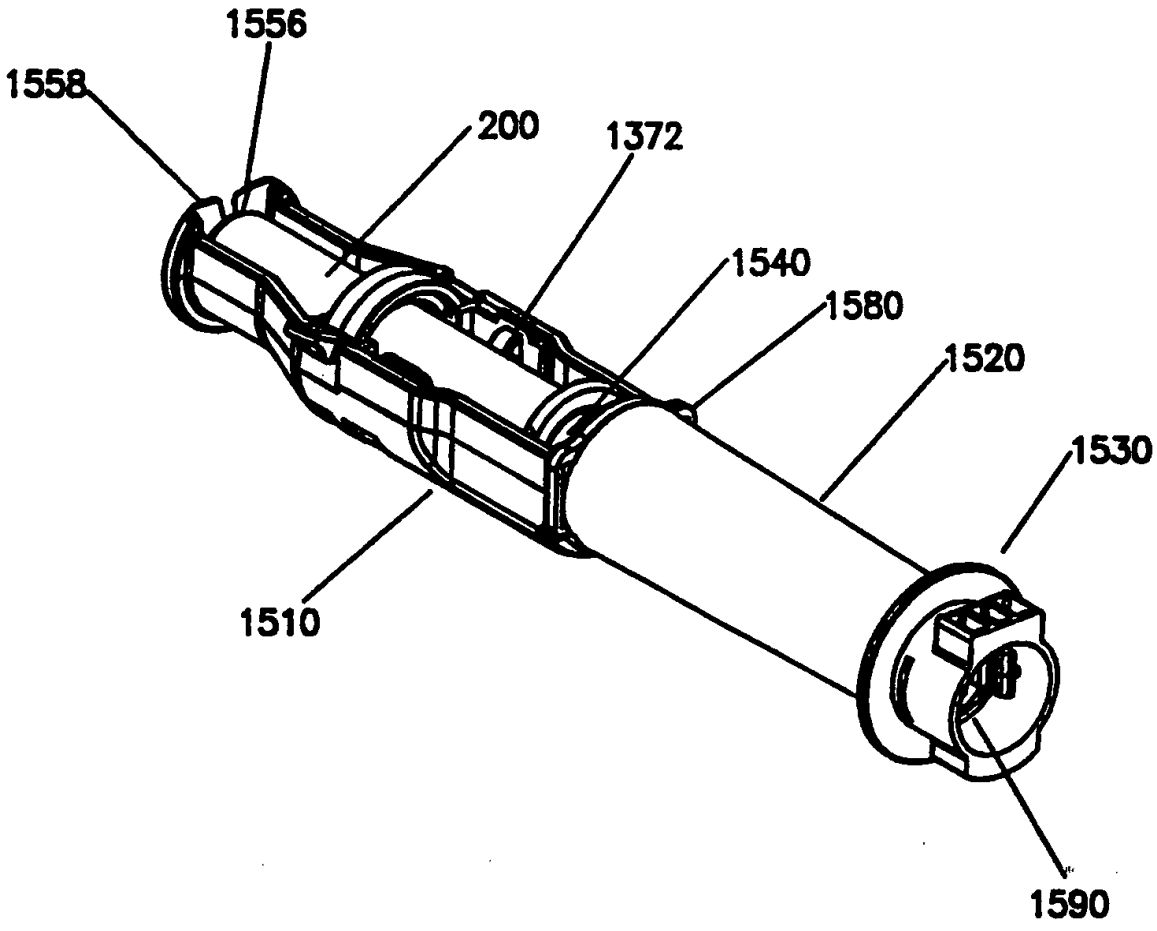

FIG. 12B

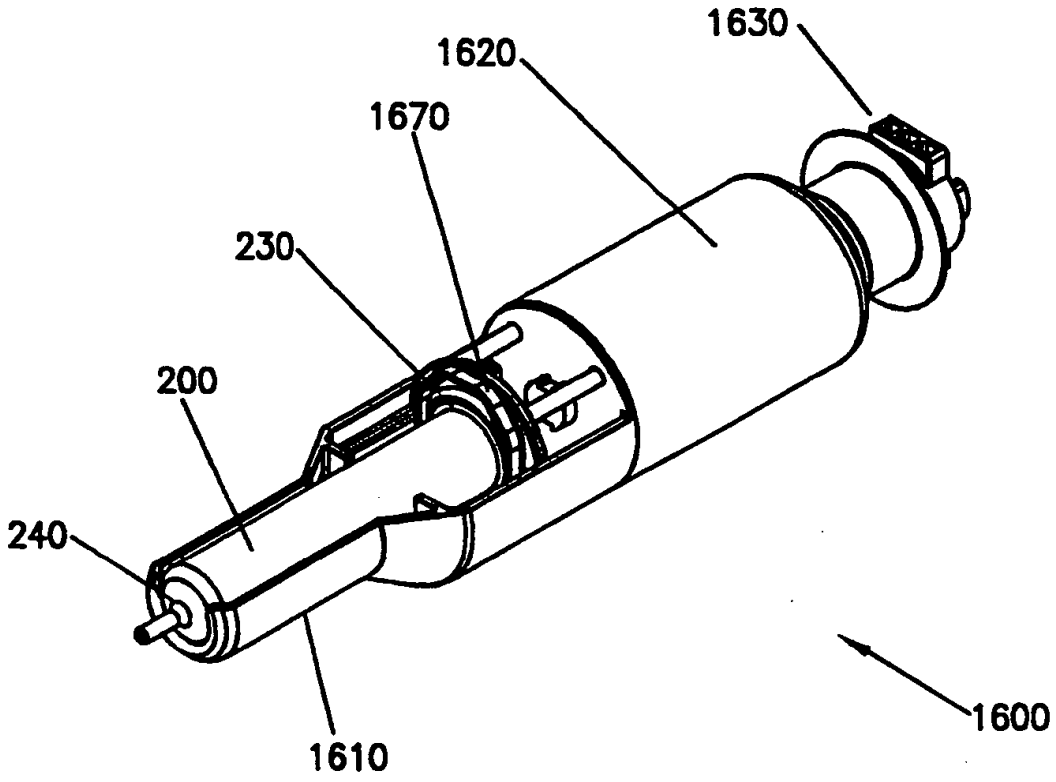

FIG. 13A

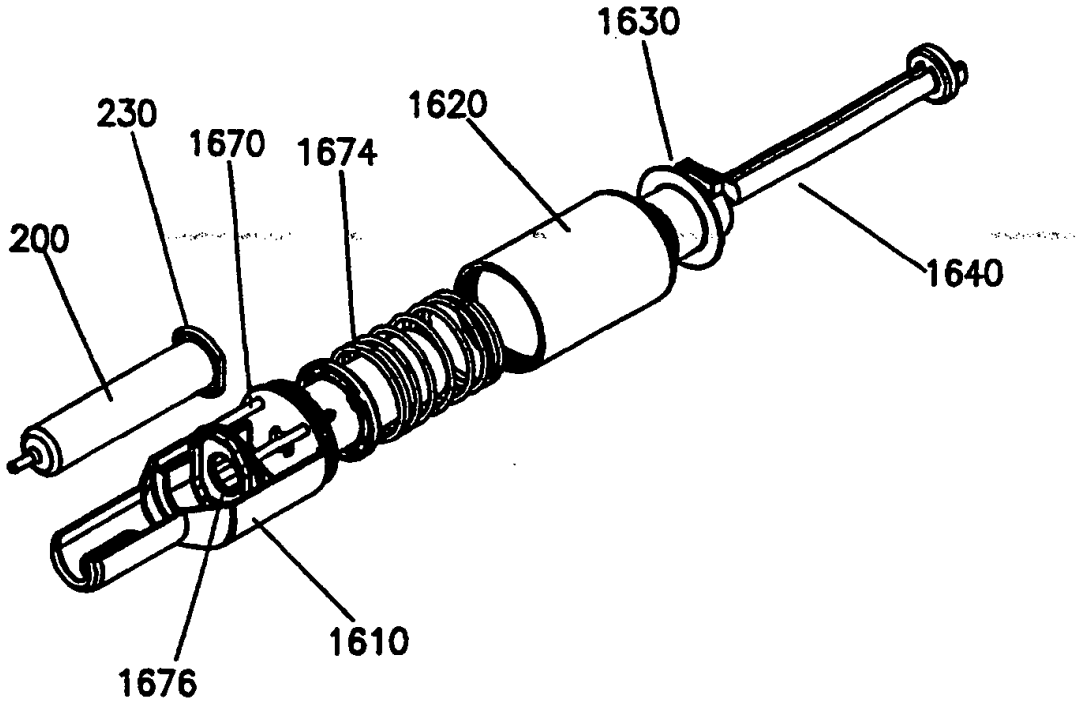

FIG. 13B

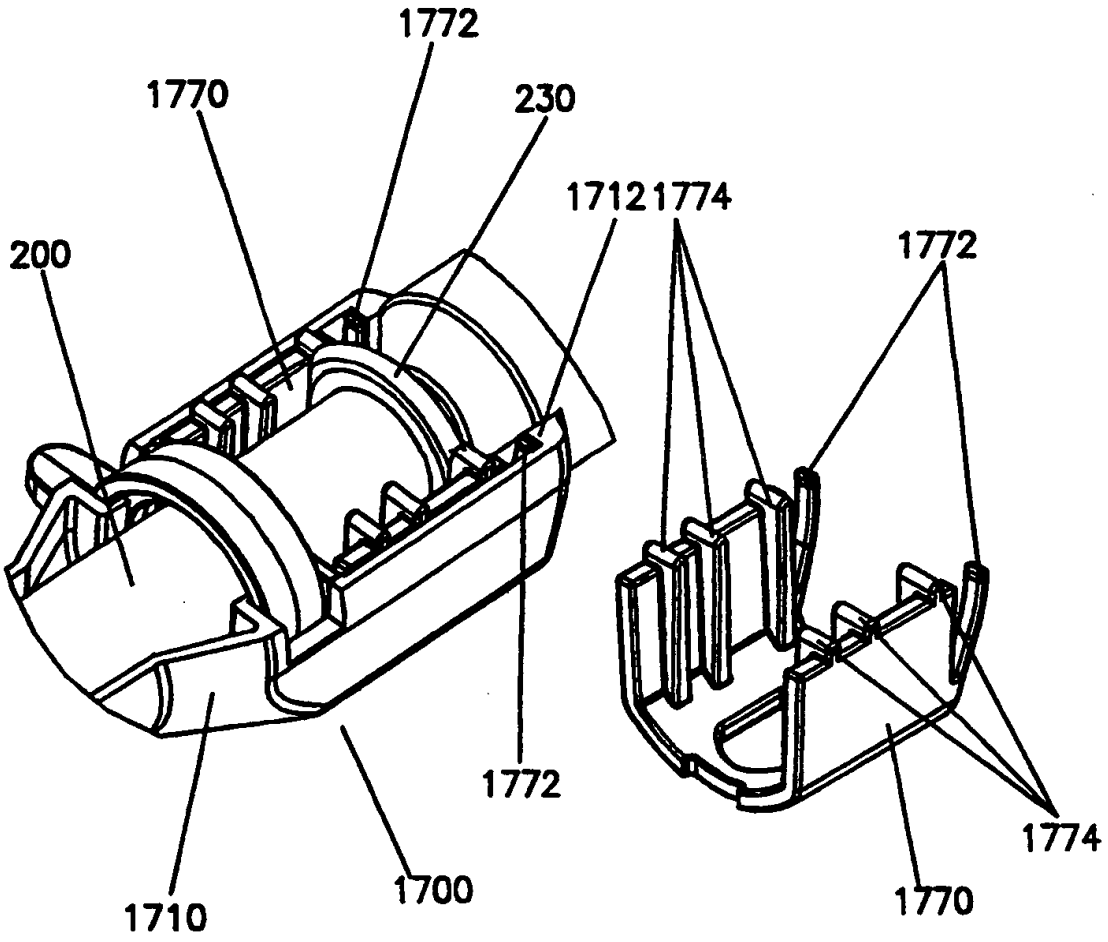

FIG. 14

INTERNATIONAL SEARCH REPORT

Internr al Application No
PCT/US 00/20623

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61M5/145

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 563 175 A (LAFOND MARGARET) 7 January 1986 (1986-01-07) column 8, line 46 - line 55; figures 1,4	8,10
X	US 5 865 805 A (ZIEMBA ROBERT J) 2 February 1999 (1999-02-02) the whole document	1-59
X	US 5 913 844 A (FAGO FRANK M ET AL) 22 June 1999 (1999-06-22) the whole document	1,3,6,8, 9,12-59
X	US 5 520 653 A (REILLY DAVID M ET AL) 28 May 1996 (1996-05-28) cited in the application the whole document	1,3, 13-59

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 November 2000	21/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Clarkson, P

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INTERNATIONAL SEARCH REPORT

...ormation on patent family members

Interna... al Application No
PCT/US 00/20623

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4563175 A	07-01-1986	NONE	
US 5865805 A	02-02-1999	JP 11155949 A	15-06-1999
US 5913844 A	22-06-1999	EP 1011760 A	28-06-2000
		WO 9857684 A	23-12-1998
US 5520653 A	28-05-1996	EP 0847287 A	17-06-1998
		EP 0987040 A	22-03-2000
		JP 11512016 T	19-10-1999
		WO 9709077 A	13-03-1997
US 5779675 A	14-07-1998	AU 6848996 A	19-03-1997
		BR 9610384 A	21-12-1999
		CN 1193918 A	23-09-1998
		EP 0851775 A	08-07-1998
		JP 11511356 T	05-10-1999
		WO 9707841 A	06-03-1997
		US 5899885 A	04-05-1999
		US 5938639 A	17-08-1999
US 5383858 A	24-01-1995	AT 181676 T	15-07-1999
		CA 2097848 A	18-02-1994
		DE 69325482 D	05-08-1999
		DE 69325482 T	28-10-1999
		DK 584531 T	22-11-1999
		EP 0584531 A	02-03-1994
		EP 0900573 A	10-03-1999
		ES 2134230 T	01-10-1999
		JP 2544571 B	16-10-1996
		JP 6154322 A	03-06-1994
		US 6090064 A	18-07-2000
		US 5795333 A	18-08-1998
		US 5741232 A	21-04-1998
		US 5997502 A	07-12-1999